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A 30-FT. DELAWARE BAY CHANNEL, to Philadelphia, is recommended by a board of U. S. Engineers, consisting of Lieut.-Cols. G. G. Lydecker and C. W. Raymond, and Major W. H. Bixby. The last Congress appropriated $500,000 towards a 30-ft. channel, 600 ft. wide, in the Delaware River; provided, that the ultimate cost would not exceed $5,935,000, as estimated by Lieut.-Col. Raymond on Jan. 5, 1898. The above board was convened to consider this estimate and other features of the enterprise, especially the Dan Baker Shoal, just below Reedy Island. At this point there is only 19 ft. of water at mean low tide, though millions of cubic yards of mud have been dredged out to a depth of 26 ft. To obviate this a new channel will be cut to the west, 9 miles long, to deep water in Delaware Bay. As an additional safeguard, to narrow the river and to concentrate the current, it is proposed to make an artificial island about 3 miles long and ¾ mile wide; this will be made of the 34,953,000 cu. yds. excavated from the new channel. The estimated total cost of the improvement is $5,810,000, or less than Lieut.-Col. Raymond's estimate. The work will be dredging in mud principally; with some bulkhead work and a little rock. The cost of dredging alone is estimated at $5,089,445, and the rock removal at $192,000.

THE PROPOSED LAKE SUPERIOR & ST. PAUL Canal has been surveyed under direction of Maj. Clinton B. Sears, U. S. Engineers, in accordance with a provision in the last River and Harbor Bill. The survey shows a distance of about 210 miles with a summit level 416 ft. above Lake Superior, and 315 ft. above the Mississippi. For a canal with 50-ft. bottom width, and 5-ft. depth, the cost is set at between $6,000,000 and $7,000,000, and the annual operating expenses at $350,000. The report of the engineer concludes as follows:

That owing to the existence of four well-equipped and competing lines of railroad parallel and near to the same commercial terminal, with the prospect of several more railroads to be built within a few years—the shortness of the navigation season in this latitude due to long and severe winters—the longer route and much longer time of transit for freight—the economic value of speed in transportation, and the cost of the canal—the construction of the canal cannot be called an urgent public necessity.

CLAIMS FOR EXTRA WORK ON THE ERIE CANAL enlargement have been disallowed by State Controller W. J. Morgan to the amount of $218,207 on Contracts 1 and 2, Middle Division, and $116,110 on Contracts 3 and 5. He finds that these contractors have now been paid more than they were entitled to by reason of improper extra allowances. He says that on Contracts 3 and 5 plans were changed and the expense increased without the consent of the Canal Board, in express violation of the canal improvement laws; and the State Engineer and the Superintendent of Public Works acted entirely contrary to the express limitations of the statute, and therefore they had no power to bind the state. To hold otherwise, he says, would result in the ridiculous assertion that the state funds are at the mercy of every public official, however limited in power, and may be squandered in any enterprise which he may claim to be for the benefit of the state, when express statutory law forbids him engaging in such undertakings.

STEAM SHOVELS FOR TUNNEL EXCAVATION were successfully employed in constructing the North Bessemer tunnel on the Pittsburg, Bessemer & Lake Erie R.R. This tunnel is 2,900 ft. long, with a horse-shoe section 23½ ft. high and 26 ft. wide, and provides for two lines of railway track. The excavation was carried on from the portals and two intermediate shafts and consisted first in driving a top heading of from 19 ft. to 21 ft. bottom width, and 8 ft. high at the center, the top conforming as closely as possible to the semicircular form of the roof. This heading was followed by two benches, the first or upper bench being loaded by means of chutes into side dump cars at the portal ends and into mining cars at the shaft heading. The lower bench was blasted loose and loaded into grading cars by steam shovels, the booms of which were shortened to permit of their entrance into the tunnel. These shovels were operated by compressed air. This bench, which was about 8 ft. high and practically the entire width of the tunnel, was taken out in 110 working days or at the rate of about 29 lin. ft. each day. The track was laid through the tunnel in less than 10 months after excavation was first begun at the portals. The material excavated consisted largely of shale rock, which had to be blasted.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred in the Dingess tunnel, near Williamson, W. Va., on the Norfolk & Western R. R., on Sept. 6. A freight train running at a high rate of speed parted and the sections afterwards came together in the tunnel, wrecking 23 cars and causing the death of seven men.—— Another serious accident occurred on the Erie R. R. on Sept. 6 at Miller's Station, Pa., where the Chicago Limited ran through an open switch into a freight train standing on a siding, and killed six persons.——The collapse of a bridge under a train loaded with granite on the Columbia, Newberry & Laurens R. R., near Columbia, S. C., on Sept. 9, resulted in the death of four men.

A SERIOUS WRECK occurred Sept. 5 in the St. Mary's River, at the encampment Island channel, near the Sault Ste. Marie locks, and stopped all navigation for five days. The steamer "Douglas Houghton" was coming down the river, with 6,400 tons of iron ore on board, and towing the steel schooner "Fritz," carrying 7,200 tons of ore. The steamer's steering chains broke and the vessel ran into a rocky ledge, while the current swung the stern round against the opposite side of the channel. The barge struck the steamer near the bow, making a great hole, and the ship sunk in a few minutes. Arrangements were at once made to unload the cargo on lighters and to repair the damage. The torn plates were cut away by dynamite and a timber patch was put on, this work being done by divers. Wrecking pumps were also got ready to pump out the water. The last piece of work was to blow away a part of the rock that held the bow, and after several attempts the vessel swung clear on Sept. 10. About 200 vessels had been delayed, and the iron ore output for the season is said to have been reduced 300,000 tons. The dredging of a deep channel on the other side of the island is proposed as a preventive against such an interference with traffic in the event of another similar accident.

THE CANALISATION OF ROCK RIVER, in Illinois, is proposed, as an adjunct to the Hennepin canal, in order to extend the benefits of navigation to the manufacturing towns on the river, between Rockford and Sterling, at which latter point water is taken for the Hennepin feeder.

A 5,000-TON SIX-MASTED SCHOONER is being built at Camden, Me., for the coal trade between Philadelphia and Maine ports. This schooner will be 300 ft. long on the keel; 330 ft. long over all; 48 ft. beam, and 22 ft. deep. Each main-mast will be 116 ft. long, top-masts 59 ft. long, five forward booms will be 42½ ft. long, and the driver-boom will be 72 ft. long. She will have a cargo-capacity of 5,000 tons of coal.

THE PEARY ARCTIC EXPEDITION has been heard from through the arrival of Lieut. Peary's steamer, the "Windward," at Brigus, N. F. On Aug. 13, 1898, the "Windward" left the "Hope" at Etah, Wale Sound, and worked 80 miles north to Cape Durville, where she was frozen in for the winter. Lieutenant Peary landed stores and his five Eskimo families and made four trips northward, leaving about 4,000 lbs. of provisions at prominent points along the west side of the channel separating Greenland from Grinnell Land. He found Fort Conger, Greeley's old headquarters in Lady Franklin Bay, just as it was left 16 years ago, with the table set for the last meal. The "Windward" brings home the property and relics left by Greeley. Peary made one trip north from Fort Conger to Beechy Cape; in April he crossed Ellsmere Land, and in May and June he worked south and secured 100 walrus and 16 musk-oxen. On Aug. 2, 1899, the "Windward" was free from ice, and Peary went in her to Cape York, gathering dog skins and sleds for his expedition next spring. He will winter at Etah Sound, and will probably start north in February, 1900, supported by his whole tribe of Arctic Highlanders. He expects the "Windward" to return in July, next year, provisioned for three years; he will then push her as far north as possible and use her as a base to make trip after trip over the Polar basin ice—until he has reached the Pole, or found that task impossible. Last winter was the coldest of his experience in the Arctic regions, the thermometer registering 70° below zero. Lieutenant Peary had his feet badly frost-bitten, and four toes of his left foot, and three on his right foot had to be amputated. Captain Svendrup, in the "Fram," was frozen in at Cocked-Hat Island, 50 miles south of Peary's winter quarters, but the parties did not meet until in the spring hunting trip. Svendrup also crossed Ellsmere Land; and he proposes to push north this summer, land on the Greenland coast and sledge around its northern extremity and down the east, uncharted coast. He expects to send the "Fram" around to the east coast to pick him up "in a year or two." The "Fram" started on the northern trip on Aug. 12, from Etah; but on the 18th had only made 5 miles and the prospects were not good for accomplishing much this season. The "Diana" landed the Stein exploring party at Cape Sabine on Aug. 5, and met the "Windward" at Etah.

THE TRAFFIC OF THE TRANS-SIBERIAN RAILWAY is spoken of as follows in an article in the "Novoe Vremia," which is translated by Mr. Hagerman, Second Secretary United States Embassy, St. Petersburg, Russia, for the U. S. Consular Reports for September:

During the first two months of the present year the amount of freight transported on the Siberian Railway amounted to 14,000,000 poods (233,333 tons), and during the same time 150,000 workmen and settlers were carried along the line. The economic impulse given to the country by the new line can be seen in many ways. In the center of great ranges of mountains rich coal mines have been discovered, and are already being exploited by several large companies. Small villages are becoming towns. On the other hand, certain industries (that of the caravan, for instance), are falling off since last spring. Nine wooden bridges on the line have been burned down by the principal carriers, or caravan proprietors, who find no more work since the railway has been inaugurated. A serious misfortune occurred in the year 1897 in the Trans-Baikal district, which was completely flooded. This occasioned not only a famine, but the necessity of making a new line for the railway for a distance of over 1,000 versts (666 miles). This flood was followed by famine, bringing with it great disaster and much disease. Radical changes must be made in the line immediately in order to handle the traffic. First, means must be organized to meet the mass of passenger and freight traffic. The great railway never expected such success, and has been built economically—steep hills, sharp curves, light rails, a limited quantity of rolling stock of bad quality, and a still more limited number of employees. It will be necessary to change the light rails for heavier ones, to renew the roadbed, to lengthen and to increase the number of sleepers; also to build switch stations at small intervals on the line in order to increase the number of trains, and to change the wooden bridges to iron bridges. It has also been found absolutely necessary to build large warehouses to preserve cereals at various points along the line. On the western portion of the line, since its inauguration, 29 new switches have been built, and 10 others are being built at the present time; in all 41 will be built. This will permit of the running of 10 trains a day. On this portion of the railway the 50 wooden bridges which existed are being replaced by iron bridges. The long-expected iron bridge over the Yenisei is now ready. It is 2,800 ft. long. In order to overcome the heavy grades on this railway, it has been supplied with locomotives of the Malet system. Unfortunately, this portion of the railway can not operate more than five pairs of trains a day. On the Trans-Baikal line nearly all the grading is ready and the rails are laid for 550 versts (366 miles) from Strietensk and 70 versts (46 miles) from Muisoff; the total length of this section of the railway is a little over 1,000 versts, or 666 miles. It is expected that by June of next year this section of the line will be in operation. About 10,000 workmen and convicts are working at the Chinese section of the line, which it is expected will be completed in three years.

THE NEW UNION STATION AT BOSTON is now a completed enterprise. The last express to New York, on the Providence Division of the New York, New Haven & Hartford Line, left the old Park Square station at 12:03 on Sept. 10, and the old building will be at once pulled down. This removal consummates the scheme of passenger train consolidation at the Union station of all the railways entering the city from the south, including the Old Colony, Midland and Providence Divisions of the New York, New Haven & Hartford, and the Boston & Albany lines.

CEMENT MANUFACTURE FROM MARL is to be commenced in Michigan, and in the past eight months about a dozen companies have been incorporated at Lansing for this purpose, says a press despatch from that city. Dr. Lane, the State Geologist, has engaged Mr. David J. Hale to investigate the marl deposits, and this material is already found in a pure and dense condition widely scattered over the state, and in deposits ranging from 5 acres to thousands of acres in extent. At the present time the cement industry of Michigan is confined to Branch county, where it is made by grinding the Coldwater shale.

THIRTY-THREE MILES OF ALUMINUM CABLE will be used by the Hartford Electric Light Co. to transmit 2,000 HP. at 10,000 volts from Tariffville to Hartford, Conn. The cable, ¾-in. in diameter, consists of seven strands, each made up of seven wires of No. 11, B. & S. gage, and is equivalent in conductivity to a No. 0000 copper wire. It is stated that, at the present price of copper, the saving to be made by using aluminum will amount to $3,500 in this case. Three-phase current is to be used, and the cables, which are bare, will be strung in an equilateral triangle on two cross arms, with double petticoat insulators.

THE FAILURE OF THE CHICAGO "COLISEUM" ROOF ARCHES.

(With full-page plate.)

The fall of the twelve steel arches forming the main roof of the new Chicago "Coliseum," was briefly noted in our issue of Aug. 31. This building was designed for convention and exhibition purposes, and was under erection at the time of the failure on the site of the old "Libby Prison" exhibition, at 15th St. and Wabash Ave., in Chicago. The collapse was complete; every one of the twelve main roof arches, which had been erected and partially connected, going down and carrying with them the workmen on top, of whom

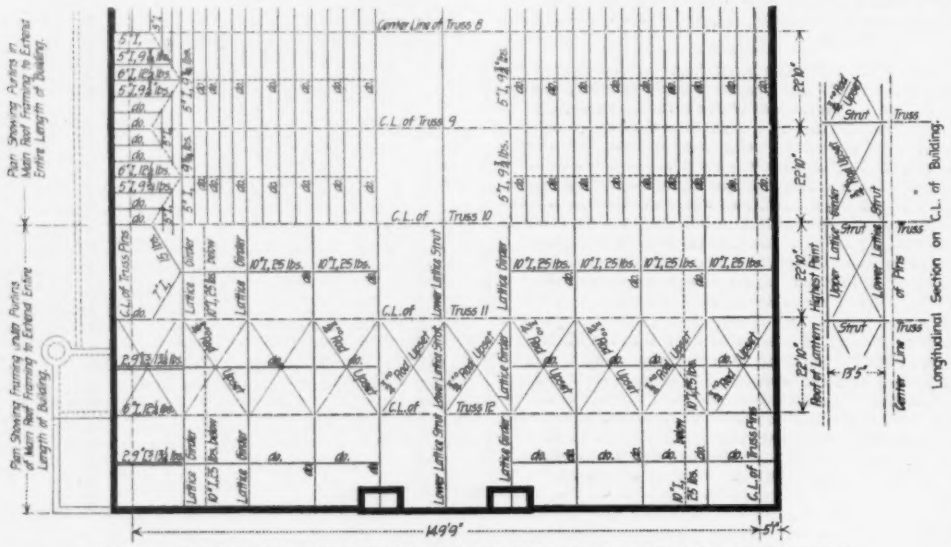
Center Line of Truss 8
C.L. of Truss 9
C.L. of Truss 10
C.L. of Truss 11
C.L. of Truss 12
C.L. of Truss Pins
Lattice Girder
Lower Lattice Strut
Plan Showing Purlins of Main Roof Framing to Extend Entire Length of Building
Plan Showing Framing and Purlins of Main Roof Framing to Extend Entire Length of Building
Longitudinal Section on C.L. of Building
Center Line of Pins
Truss
Strut
Upper Lattice Girder
Lower Lattice Girder
Roof at Lantern
Highest Point
149'9"
51'

FIG. 2.—PART PLAN SHOWING ROOF FRAMING FOR CHICAGO "COLISEUM."

twelve were killed and about the same number more or less seriously injured. Various conflicting stories have been circulated regarding the cause of the accident, and the exact manner in which it occurred, and we have thought it advisable for this reason, as well as for the lesson which the disaster teaches, to lay before our readers the exact facts as fully as we have been able to obtain them up to the present time.

The new "Coliseum" building was designed to occupy a ground area of 300 × 160 ft. Its principal structural feature was the series of twelve roof arches spanning the main auditorium. These roof arches were of the three-hinged type, with the bottom pins connected by a tie-rod running transversely across the building underneath the floor. The span of the arches was 149 ft. 9 ins., c. to c. of shoe pins, and the vertical height from the center of the shoe pins to the center of the crown pin was 66 ft. Fig. 1 shows the strain sheet, general make-up, and important individual structural details of one of these arches. Fig. 2 is a part plan of the roof framing. The spacing between the two middle roof arches was 25 ft.; at the north there were five spaces of 23 ft. 6 ins., and at the south five spaces of 22 ft. 6 ins. The feet of the arches were carried in cast-iron shoes resting on concrete piers or skewbacks, supported by piles from 45 ft. to 50 ft. long. Each shoe was anchored to the concrete by four 1½-in. anchor bolts 3 ft. long, and the 2½-in. square tie-rods passed in a loop around the middle of the shoe pins. Other details of the construction of the arches proper are shown by Fig. 1.

The general arrangement and character of the lateral bracing connecting the arches are shown by Figs. 1 and 2, but as this bracing appears to have played an important part in the failure, it is desirable to note it fully. At the hips of the arches they were connected by longitudinals composed of two 15-in. channels arranged back to back, but below this point there was no longitudinal bracing between the arch ribs. At the third panel point above the hips and at each succeeding third panel point, and at the crown, the arches were connected to each other by lattice girders. The apex girder, it will be noticed, carried posts which supported a lattice girder forming the ridge framing for the skylight. Besides these longitudinal struts between all the arches there was between the first and second arches from each end a system of X-bracing in the plane of the lattice struts. The purlins and roof covering formed the only other connections between the arches. The reason given for the omission of bracing between the arches below the hips was that the outer chords of the arches for this distance were to be enclosed in the masonry walls.

So much for the roof framing as it was designed; the actual condition in which it stood at the time of the accident was quite different. Figs. 3 and 4 are views taken of the roof the day before the accident. These views show the entire twelve arches erected, and a portion of the longitudinal bracing in place. The portion not in place comprised the channel beam struts at the hips, the lattice beam at the ridge and the X-bracing at the north end of the roof. In other words, four lines of lattice struts on each side of the crown or ridge of the building was practically all that existed to brace the building longitudinally at the time of the accident. These lattice struts were not completely connected up. Just how fully the connections had been made, however, is not easy to tell from the evidence at hand. Neither the photographs of the standing framework, Figs. 3 and 4, nor those of the wrecked arches, Figs. 5 and 6, give any information upon this point. Mr. John W. Hersey, a civil engineer, who examined the wreck, however, made the following statement, which was published in the "Times-Herald" of Chicago:

> I made a careful examination and found, to my satisfaction, that the struts, that is, the braces between the arches, were only partly placed, and that those which had been put in were not securely bolted. In each strut, as I remember, there are twelve bolt holes, six at each end. Those that I saw had been held in place with only two or three bolts, and those were not tightened. I saw a number of bolts that had been stripped of their threads in the fall. That argues only one thing, that they were not tight. A bolt that is set tight will not strip its threads under a strain. It will cut squarely off, but if there is a chance for a little play the threads will give and allow the nut to slip over the end.

Whether the conditions were exactly as stated here or not, we cannot say; but it was a fact that the struts were only partially connected up, and also that the riveting up of the arches proper was in progress, the temporary connections having been made with bolts. The work was proceeding from the south end of the building toward the north end, and the north end arch had been erected the day but one preceding the accident. The riveting on this arch was in progress, and the traveler by which it had been erected was being taken down. Between the north arch and the one next to it, all the main, or latticed, purlins had been put in. Of the knee braces which connect the arch ribs to these purlins, two were in place on the east side and seven on the west side. The arch had, of course, no support from the north, as the north wall had not been built. The lines of lattice girders would eventually have been carried from the north truss to the wall, as shown by the plan, Fig. 2. All the bracing was not permanently riveted up, but the purlins were temporarily secured to connection plates in the arch trusses.

The initial cause of the failure seems to lie in the manner of conducting the work of removing the traveler, which was a rectangular scaffolding of timber some 40 ft. high, carrying four derricks, and located almost directly under the end arch. The erection was done by means of this traveler. The sides or legs of the trusses were built up to a point above the floor of the traveler by means of gin poles on the traveler. The two arch sections were then erected on the ground and hoisted into position. The last (north) truss had been erected Saturday, Aug. 26, and on the day of the accident (Aug. 28) the traveler was being taken down. For this work, a hoisting engine on the floor level, about 140 ft. south of the end truss, was used, and the rope was led up to a block attached to the truss, near the crown, having thus a rise of 66 ft. in a distance of 140 ft. The rope was attached to one bent of the traveler and was hoisting upon it when the accident happened. The supposition is that the lateral pull, aggravated, perhaps, by a jerk or lurch of the weight as it swung free, jarred the arch free at the top pin bearing (where the top lines of purlins in place were 30 ft. apart), or in some way pulled it over.

FIG. 3.—VIEW OF CHICAGO "COLISEUM," SHOWING CONDITION OF STEEL ROOF FRAMING THE DAY BEFORE THE ACCIDENT.

From the position of the engine it is clear that the pull acted to draw the arch over sidewise toward the engine, as each timber was lowered. That this overturning pull caused the north arch to break apart and topple over sidewise is, of course, denied. That it might have easily have caused such a failure is plain from what has been said, and that it probably did cause it is indicated

by the evidence of those who were in the accident. Some of the men who were at work on the roof have stated that it vibrated longitudinally before it fell. It was, moreover, the north arch that fell first. Mr. D. W. Church, the engineer for the contractors, who witnessed the accident, is quoted by the daily press as saying:

> I was looking on with E. C. Shankland, chief engineer of the building, and Mr. Peaslee, foreman of the gang engaged in the erection of the arches, when the collapse came. I noticed the arch at the north end swerve and jerk and then slowly fall. The others fell in succession until the last one had come down.

This is exactly the behavior which would be expected if the arch had been wrenched over by the pull of the hoisting engine, viz.: first a premonitory vibration as one timber after another was lowered, then a swerve and jerk of the arch under strain, and, finally, the fall of the succeeding arches, because their longitudinal stability, owing to the insufficient bracing, was not great enough to withstand the shock tending to overturn them.

The trusses were not all entirely riveted up, but there were enough rivets for strength and stability in all the trusses. One hip joint of the second truss from the north had only about half the rivets driven, but in spite of the shock of the fall the joint has only been sprung. The trusses fell clear of the shoe pins, several of which are still in place in the shoes, which are practically undisturbed. All the trusses lie within the lines of the shoes. As to the way in which the longitudinal bracing behaved in the fall, it may be said that in most cases the connection plates at the ends of the lattice girders and the channels, and of the knee braces of the lattice girders, bent in an even curve, until the girders lay flat against the trusses. In some cases the plates were twisted and torn or the rivets and bolts were sheared. There was no diagonal bracing between the trusses, or between the trusses and the girders, to prevent this. Consequently the trusses could easily slew when struck, and when the slightest slewing occurred there was nothing but the thickness of the connection plates to resist the longitudinal strain and the plates bent like paper. This seems further to support the theory that the north truss was jarred or pulled from its pin bearing at the crown, for the connections would have stood a direct longitudinal strain. In fact, they have stood the strain due to a severe wind storm. With the two halves of the north truss falling inward and backward, however, the longitudinal members and their connections would be twisted and tend to slew the next truss in such a way that the longitudinal thrust on the purlins was changed into a bending strain on their connection plates, which they were never intended to receive. This would be repeated from truss to truss, each truss slewing and falling as it received the eccentric strains from the adjacent truss to the north of it, and in turn forcing over the next adjacent truss to the south.

At the coroner's inquiry the use of the hoisting engine was the principal matter investigated. It was claimed on behalf of the contractors that the weight lifted could not have exceeded two or three tons, and was entirely insufficient to affect the stability of the arch. The side pull and swinging and jerking load, however, and some instability due to the existing condition of the lateral bracing as erected, seem to have been sufficient in combination to account for the accident. Fig. 7 is a rough sketch showing approximately the state of affairs at the time of the accident, and one statement that has been made is to the effect that the foreman should not have allowed the rope to be in the position shown, but should have run it along the floor and through a snatch block, and thence up to the arch, as shown by the dotted lines. We are informed of one case, however, where a rope hanging from the arched truss of a trainshed under erection got caught by a locomotive below, and the engine pulled until the rope broke, the structure being so braced that even this concentrated force, applied at such an angle, did not disturb the trusses. There have been reports that some of the lateral bracing was removed to allow of swinging some of the heavier longitudinal members into place. This was at the south end of the building, however, where diagonal bracing which had been put in between the two end trusses for erection purposes was being removed to make way for the permanent work. This could hardly have effected the accident in any way.

Fig. 4.—View Showing Absence of Longitudinal Bracing At and Below the Arch Hips, Taken the Day Before the Accident.

The preceding paragraphs give the salient features of the new "Coliseum" failure as fully as we have been able to ascertain them. In the examination of the wreck which is now going on it is possible that more complete information may be brought out, but we think that engineers will agree that we are entirely reasonable in assuming that the conditions which we have described were amply sufficient to explain the accident without further investigation. The lesson which the disaster teaches is plain enough. It would have been a very easy matter for the contractors to have ensured themselves against such a failure at no very great expense and labor, but they took the chances, and as has often been the case before when this has been done, they have to suffer as a consequence.

In conclusion it may be noted that this was the third structure of the same name to be erected in Chicago; the first one having failed by the collapse of its roof arches, much in the same manner as in the present disaster, and the second one having been destroyed by fire on Dec. 24, 1897. A full description of this second building was published in Engineering News of Nov. 12, 1896, and the first structure, which it succeeded, was similar in all respects except that many of its details were strengthened and modified before using the plans for the construction of the second building. The reason for the disaster to the first "Coliseum" was never fully determined, or at least, it was never made public, but several causes were assigned to account for the failure, among which were: the improper loading of the structure with piles of material for the roof; weakness in the pedestals or bearings for the feet of the arch, and generally faulty design in several details of the arch and roof framing. As there was evidence to show that each of these faults existed at the time of the failure, it perhaps does not matter much, however, which one was the most directly responsible.

The designs for the steelwork whose collapse we have described were prepared by the engineering firm of E. C. & R. M. Shankland, of Chicago, and were in general similar to that for the Manufactures Building at the Columbian Exposition, the 16th St. Armory, and other structures of a similar class designed by Mr. E. C. Shankland, M. Am. Soc. C. E. The contract for the construction and erection of the ironwork was let to the Pittsburg Bridge Co., of Pittsburg, Pa. The architects were Messrs. Frost & Granger, of Chicago; and the contract for the masonry was let to the Grace & Hyde Co., also of Chicago. It is reported that the reconstruction of the third "Coli-

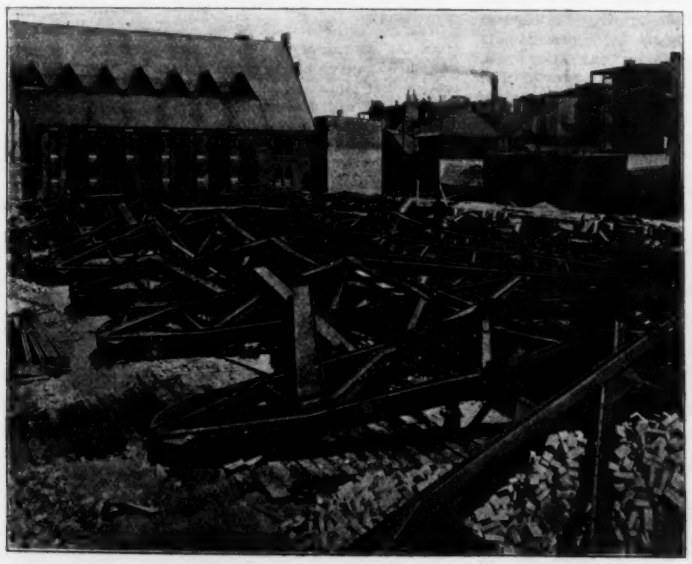

FIG. 5.—VIEW LOOKING NORTH ALONG THE WRECKED ARCHES, CHICAGO "COLISEUM."

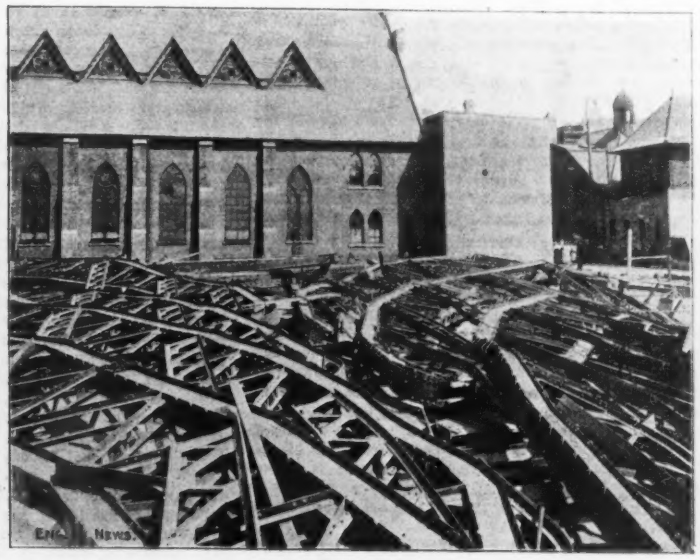

FIG. 6.—VIEW LOOKING NORTH ALONG THE WRECKED ARCHES, CHICAGO "COLISEUM."

seum" building will be commenced as soon as possible, following the original plans. It is thought that much of the material can be used over again, but the removal of the wreck, and the cutting and splicing required, together with the handling of the mass of material, will be somewhat difficult and costly work.

COATINGS FOR CAST-IRON WATER PIPES.*

By Thos. H. Wiggin.

It is probable that nearly every engineer who has had a large number of pipes to lay has resolved that he will do something to dispel the mist that hangs about the subject of preservative coatings. Very many seem to have made concoctions of coal tar, asphalt, linseed oil and other things, in the endeavor to strike the fortuitous combination of cheap products which would adequately protect the metal. If all these experiments could be published the engineering world might finally arrive at a choice by rejection. As it is, the same ground is covered several times over with the same disappointing results. The question of preservative coatings belongs properly to the skilled chemist, but it has been attacked with some assurance by persons (including the writer) who are not chemists. The results of the writer's observation, study and experiment, made in connection with the Metropolitan Water-Works, will be given.

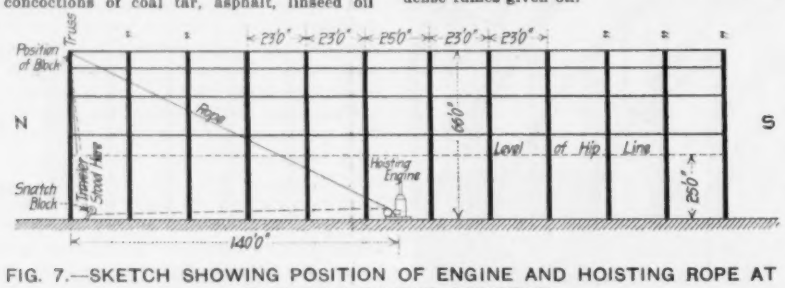

FIG. 7.—SKETCH SHOWING POSITION OF ENGINE AND HOISTING ROPE AT THE TIME OF THE ACCIDENT.

Coal-Tar Coating.

The inspector having passed judgment on the pipes, they are rolled along down to the coating apparatus. The apparatus consists of a number of ovens, with iron cars, on which the pipes are rolled into the oven and on which they stand during heating, a vat or tank for the coating compound, a crane for hoisting the pipes in and out of the vat, and various brushes, scrapers and mops for brushing out dirt and removing surplus coating material. The coating material is crude gas-tar with sometimes some dead oil of tar added. The pipes are given a fairly good brushing before being put in the oven. The oven is merely an enlarged chimney flue, for all the smoke and gases of combustion pass in at one part and out at another, so that a light, but visible deposit of soot is made on the pipes, which is not brushed off. The old-fashioned ovens have simply a square hole through the floor of the oven connecting it with the fire, so that the hot gases, and occasionally flame, act principally upon one portion of the pipe, heating that portion very hot before materially affecting the other portions. The newer ovens are fitted with an arched bottom, with bricks left out at intervals all along the pipe, this arrangement causing a more uniform temperature. The pipe is left in the oven until the attendants think (no thermometer is used) it is heated to about the correct temperature (48-in. pipes are left in about 20 minutes); then it is put in the tar to stay from a moment to ten minutes, according to the condition of the work about the vat. On being removed from the vat, the pipe is allowed to drain over the vat, and the drainage is aided by scraping the invert with a segmental hoe, made to fit, or at least to be of smaller radius than the pipe. The pipe is then lifted out onto the skids and the coating smoothed up further—surplus tar removed and thin places reinforced—by a brush or a mop. The brush is better because the mop leaves part of itself behind on each pipe. The coating becomes hard in from ½ to 2 hours, according to conditions.

Coal-tar is a very complex mixture; indeed, the fact is so well known that people are not seldom heard calling a doubtful drug "one of those coal-tar products." Moreover, coal-tar varies very widely according to the coal used and the temperature maintained in the manufacture of the gas. Furthermore, crude tar varies at different heights in the tank in which it is collected at the gas works. But no tests are made to obtain any particular kind of tar for coatings. The unrefined overflow from the hydraulic main of the gas plants is purchased where it can be obtained easiest and cheapest. Specifications often call for deodorized tar, but the most noticeable thing about coating tar is its dense and pungent fumes when heated.

The degree of fluidity of the tar varies with the composition and with the temperature. In summer tar is usually more fluid than molasses; in winter it has often to be melted out of the barrels. This crude tar cannot be used as a paint for cold surfaces, because it will not harden. Tar from the coating vat, though always somewhat refined by the continued heating, does not harden sufficiently when applied to cold surfaces. This suggests the philosophy of the whole tar process of coating. By the heat of the pipes the tar is distilled down to a compound which is solid at atmospheric temperatures. A very favorable condition for this volatilization of the liquefying constituents (which are also the most volatile constituents) evidently exists when the tar is exposed to the air, spread, as it is then, in a thin film over the hot pipes; and that rapid volatilization takes place at this time is indicated by the dense fumes given off.

As a corollary to the foregoing it follows that the temperature of the pipe, as it emerges from the tar bath, is one vital factor in the character of the coating. If the pipe is too hot, the coating is over-distilled and becomes too brittle, or may even be reduced to an earthy, carbonaceous residuum. If the pipe is too cool, a thicker coating is formed, which will not harden sufficiently, will come off in the skids and will run in warm weather. Thin pipes must be heated hotter than thick pipes, because the thin metal does not hold the heat so long, and hence the distillation must be more rapid at first. The writer made an attempt to measure the temperature of some pipes just before they were dipped. An ordinary thermometer was of course of no use, nor could an electrical device be found which experts would recommend to record such low temperatures. Hence the writer procured several chemicals which are said to pass through noticeable changes at certain fixed temperatures: red iodide of mercury, which is said to change to the yellow at about 300° F.; yellow stick sulphur, which fuses at about 235° F., and silver nitrate, which fuses at 424° F. Every pipe which was tried turned the red mercuric iodide to the yellow form, but no pipe, apparently, fused the silver nitrate. The effect on the latter and on the sulphur was hard to observe on account of the heat and smoke; hence the only conclusion that could safely be drawn was that pipes, just before coating, are usually considerably over 300° F. With tar and thickness of pipe so variable, the proper temperature must be a matter of judgment on the part of the dipman. A reliable and handy pyrometer would help, however, as it would enable the dipman to use the experience gained on one pipe in judging of the next one.

There is no question about the importance of having ovens properly arranged to heat the pipes uniformly. The brick fire arch, having bricks left out at intervals all along the position of the pipe, is rather satisfactory. The single opening at one end of the pipe is decidedly unsatisfactory. The soot that is deposited on the pipes may do some harm. More elaborate and more nearly perfect schemes for heating pipes will quickly suggest themselves, but it seems probable that a careful application of the present methods will give results as satisfactory as a crude tar coating warrants. Careless application will vitiate any method. Thus, at one foundry the pipes are often wittingly under-heated on days when strong northerly winds prevail, because the wind makes it difficult to heat the ovens, and the day's work must be done just the same. Again, the pipes which stay in the oven during the dinner half-hour are liable to go into the tank too hot, because they are left in the oven too long and are not allowed to cool down. In general, the men fall into a certain routine of work—so many pipes to brush out, so many to mop out, so many to roll into the oven, etc., between dippings, and this routine fixes the time of heating. A good dipman will not allow very noticeable errors in temperatures to pass, but he will not delay the routine for minor errors. In other words, the application of the method is inferior to the best judgment of the dipman.

The character of the tar in the bath is another important variable. New tar gives softer coatings, other things equal, because it contains more of the lighter constituents. Thick tar gives thicker coatings than thin tar. The temperature of the pipe should be varied to meet variations in the coating compound. Fresh tar requires a hotter pipe than does old tar. Regularity in adding new tar would give greater uniformity in coatings, but tar is often not in stock when it is needed, and the dipman does not care much, so long as the coating passes—and the inspectors do not usually pretend to know much about coatings or to judge them very harshly.

The temperature of the tar itself does not count for much when the pipes are heated before being dipped, as is universal now. In the old method of heating the pipes by allowing them to remain in the dip half an hour or so, the temperature of the dip was very important, though less so than it would have been with crude tar. The temperature of the tar in the present method is usually about 220 to 230° F. Observations of men at the foundry on temperature of the dip, and the writer's observations on small quantities of tar, indicate that new tar, on account of the lighter constituents,* does not at first rise above 220° F. Later it rises to 350° F., if heated sufficiently. It is evident that the old method of allowing the pipes to come to their proper temperature in the dip would lead into difficulty if the crude tar was fresh in the tank, as it would be difficult or impossible to raise the pipes to the required 300° or more.

Small pipes are, as a rule, carelessly heated, and the writer has often seen very hot pipes lowered into the tank, where they caused a violent boiling and much yellow smoke (yellow smoke is the founder's sign of an excessively hot pipe). An inspector said that at one foundry pipes hot enough to set fire to the tar are so common that lids are rigged so that they can be rapidly unhooked and allowed to fall over the tank and smother the flames.

Dead Oil.

Specifications often call for the use of dead oil of coal-tar in the dip. Dead oil is defined as that part of coal-tar which is obtained, in fractional distillation of coal-tar, between the temperatures of 410 and 750° F., approximately. It contains both the creosote and the anthracene oils. Whether the commercial article agrees with this definition is unknown to the writer.

Some commercial dead oil that the writer tried evaporated about one-seventh as rapidly as water, both being exposed to the air. A brown cake was left in the bottom of the vessel. The misconception is probably often entertained that dead oil bears to tar coating a relation similar to that of linseed oil to paint. A better comparison would be that between dead oil in coal-tar and turpentine in paint. Dead oil is of use principally to thin back the tar when it becomes thicker than the dipman likes it. Ordinarily, the necessary adding of fresh tar is sufficient to keep the tar thin. At one foundry no dead oil would ever be used if the engineer did not occasionally require it. At another foundry it is the regular practice to use one barrel of dead oil to about seven of coal-tar. A change was made at one foundry from no dead oil to about the above proportions, but it had no visible effect on the character of the coating. The effect on the composition of the tar dip was to increase the proportion of the heavy oils in the tar from about 25 to about 35%, and perhaps the change really did improve the coating.

Tar and Linseed Oil.

The use of linseed oil in tar coatings dates back to the first tar coating of Dr. Robert Angus Smith, a patent for which was taken out in Great Britain in 1848. The patent states that pipes were first to be cleaned and then preferably coated with linseed oil. Pipes might be heated before dipping or allowed to come to a heat in the mixture. The tar was distilled to "a thick, pitch-like mass," and kept at a temperature of about 300° F. Pipes were left in the dip about thirty minutes. Dr. Smith found it "desirable to pour a quantity of linseed oil on the coated surfaces," which process had "the effect of removing any excess of tar, and the oil running into the tar kept it fluid and prevented its becoming unsuitable for further use." Such was the first coating of Dr. Smith. The writer found several different coatings described as Dr. Smith's, and it is probable that the doctor improved on his original one. The foundrymen to-day often call the crude tar coating in present use "the ordinary Angus Smith coating." In "Water Supply of Cities and Towns," by William Humber (1876), two methods used by Dr. Smith are given. In both, the dip contained gas tar, Burgundy pitch, oil and resin, the percentage of linseed oil in the second method being five or six. In the first of these methods the pipes were heated to from 400 to 500° F., and the dip was also kept hot. In the second, the dip only was heated, and the pipes were allowed to take the temperature (300° F.) of the dip. It was supposed that the pores of the iron opened to receive the tar.

The questions that concern us now are whether linseed oil improves the quality of tar coating, and, if so, what method can be adopted for its use. On the first question we seem, as usual, to have no direct evidence. Old foundrymen will say that the present coating is not so good as the former coating was, but there are no comparative records available, so far as the writer knows. The writer has been unable to find out from records, or by questioning foundrymen, how much and in what ways linseed oil was used in the past, and when it ceased to be used. One very intelligent employee, who had been in the foundry business for about twenty years, thought there

*Extracted from a paper on "The Manufacture and Inspection of Cast-Iron Pipes," read before the Boston Society of Civil Engineers, and published in the Jour. Assoc. Eng. Soc., May, 1899.

*The law of fractional distillation is that a mixture, when distilled, remains at the boiling temperature of that constituent which boils at the lowest temperature until that constituent is gone; then rises to the next lowest boiling point and remains there, and so on.

had been no linseed oil used at the foundries around Philadelphia since about 1872. Specifications throw little light on the subject, as they often contain directions that are not followed. It seems probable that the practice of using linseed was gradually dropped, perhaps on account of a change in the character of the tar obtained from the gas works, perhaps for other reasons of convenience; perhaps with the knowledge and consent of engineers, and perhaps without their knowledge. At any rate, the comfortable feeling of a question pretty well solved has continued; though perhaps, if the truth were known, the modern crude tar coating would be found to be living on the hard-earned reputation of the linseed oil coating. If records of the composition and behavior of coatings had been carefully kept and made available to students of the subject, many years of experience, now of little use, would have been saved to the world; and unless more care is taken, the next generation will make the same complaint.

In default of sufficient experience, we must resort to theory. The japan coating of Edward Smith & Co. is the result of careful theorization,* and the pamphlets issued by that firm, containing articles by Mr. A. H. Sabin, chemist for the firm, and by others, give many facts in regard to preservative coatings. Mr. Sabin puts up a very strong plea for linseed oil, but he discards coal-tar as a filler, and accepts copals and also asphalt, which chemists usually consider as a more enduring compound than the complex and volatile coal-tar. Mr. Sabin is also enabled to use a large percentage of linseed, and without any injurious dryer, because he bakes his coating. Now, whether or not the asphalt is better than tar, the arguments brought forth for the use of linseed seem pretty strong, and the writer would make use of them to give some evidence that linseed oil would improve coal-tar coating.

Assuming, at any rate, that linseed oil would improve tar coating, the writer attempted to find out how it could be successfully applied to the present practice. At the McNeal foundry an experiment had just been tried with an imported English tar and raw linseed, the fact that crude American tar could not be used with linseed having been proved at this foundry in previous years. The English tar was said to be somewhat refined, but appeared about the same as the American crude tar. The tar pit was cleaned out and English tar and raw linseed, in the proportions of ten tar to one linseed, were put in. The mixture became thick and lumpy, and all efforts to make a passably smooth coating failed. Even a temperature of 350° F. failed to improve matters and pipes had to be recoated. No more linseed was added to the dip, but fresh tar and dead oil were added as needed, so that the proportions of linseed steadily grew less. Finally the tank was cleaned out and the use of crude American tar resumed.

The following is a description of some of the experiments tried by the writer with tar and linseed: The mixtures were made mostly in ten-quart porcelain-lined kettles. The specimens coated were fragments of pipes, the pieces being usually about 3 to 5 ins. wide and 0.5 to 1.25 ins. thick.

(1) Twenty-eight parts of English tar and 1 part of raw linseed. The linseed, cold, was added to the tar at 240° F. Violent frothing took place. The mixture soon doubled its volume and ran over. Coating out of the question for practical use on account of frothing and lumpiness.

(2) Twenty-eight parts English tar plus 3 parts raw linseed that had been boiled for ten minutes. Ingredients mixed with tar cold and brought to liquid state at about 340° F.†. Less frothing than before, but coating useless. Soft oil collected next the iron, and dull earthy tar outside. Dead oil helped matters somewhat, but coating remained useless.

(3) Twenty-eight parts English tar plus 1 part commercial boiled linseed (guaranteed by an acquaintance as not having been boiled "through the bung-hole"). At 230° F. violent frothing occurred; and, though a fairly good coating was obtained on a small scale, the method is out of the question for regular work. Dead oil did not help.

The foregoing experiments indicated that such crude tar could not be used.

(4) In order to get tar at least somewhat refined, took four quarts of tar from the coating tank. Added ¼ quart of boiled linseed oil thereto. Frothing was too vigorous for any thought of practical application.

(5) Boiled some crude tar for about 5½ hours. At the start, the tar was a thin fluid at atmospheric temperature. After boiling, the tar was a soft solid at atmospheric temperature. During boiling, the temperature of the tar remained at about 220° F. for about an hour, then rose to about 290° and stayed there for a time, and finally became about 350°.

To 16 parts of this boiled tar added 1 part of boiled linseed. No frothing occurred, even at 400° F. The mixture was thick and did not harden sufficiently on fragments of ½-in. pipes. Later it occurred to the writer to try thick pipes (an inch or more thick), and there was no difficulty in getting the coating even too hard. No frothing occurred when dead oil was added to thin the mixture.

*Also of much experience, though not with conditions such as exist in water pipes.

†This temperature seems abnormally high in view of the other results.

The experiment showed that linseed oil could be used with partially refined tar, but it also indicated that the application of the method required more intelligent care than does the crude tar method.

Since making these experiments, the writer has found an old specification for tar coating, the method of which agrees so closely with the results of these experiments that the following quotation is made.* "The varnish, or pitch, is to be made from coal tar, distilled until all the naphtha is removed, the material deodorized and the pitch reduced to about the consistency of wax or very thick molasses. At least 8% of heavy linseed oil must be added." It is rather humiliating to come back to the results of thirty years ago. It would not be so if the old method had been deliberately abandoned for a better one; but, as already intimated, it is not apparent that such was the case.

Refined tar is now out of the market, though a tar residuum or pitch is used in roofing and for walks. As the above experiment indicates, it would be an easy matter to make some refined tar.

Procured some of the roofing pitch mentioned above. It is a solid, just viscous enough to slowly find its level in warm weather, but hard and brittle in cold weather.

(6) Roofing pitch alone. Coating was thick and very glossy, but of course rather brittle. Such a coating might give excellent results if handled only in warm weather, but would probably fly off in cold. This coating has stood water tests for about a couple of years without losing its smoothness and luster.

(7) Nine parts of roofing pitch and one of boiled linseed. A thick, glossy coating, not so brittle as pitch alone.

(8) Nine parts pitch to 2 boiled linseed. Better than 7 as regards brittleness.

(9) Nine parts pitch to 3 boiled linseed. Coating more bulky and less smooth than the others.

A greater proportion of the linseed would make the coating like paint, and drying would be too slow, unless baking were resorted to, as in the Sabin japan.

Asphalt Coatings.

It is truly charged against coal-tar that it continues to decompose, so that finally nothing but a friable, earthy pitch is left. It is said to be characteristic of pyrogenic (fire-formed) compounds, to which class coal-tar belongs, that they are unstable at ordinary temperatures. Asphalt also decomposes with exposure, as demonstrated at the natural asphalt lakes, but nevertheless is thought to be more durable than coal-tar. The only direct long-time comparisons that occur to the writer are in the matter of walks and pavements, and here there is no doubt that the asphalt has demonstrated its superior durability. However, the conditions in a water pipe are different from those of a street surface; moreover, a coating material might be very durable in itself, and yet not form an impervious coating, as is the case with pure linseed oil used alone. Asphalt has not the aggressive penetration of coal-tar, nor does it stick to things and cover everything so persistently as tar. A little drop of tar will smirch skin, clothes, paper and everything that comes near it without apparent diminution in size, while asphalt can be handled with impunity.

The usefulness of asphalt as a pipe coating compound for cast iron has never been demonstrated, though asphalt has been and is still used largely in coating steel pipes. Some information on its success for steel pipes should be available by this time, but little has been published.

The writer tried many experiments with Alcatraz, or California asphalt. Grades of several degrees of hardness are made, and by mixing grades it is comparatively easy to get a good consistency. A temperature of about 260° F. was needed. The coating is not brittle, not very smooth, rather dull and not very tenacious. In fact, the impressions of the coating were rather of a negative nature. There were no glaring defects in the coating, neither was it very attractive.

Linseed mixes well with asphalt, but the coating does not harden unless a hard grade of asphalt is used.

P. & B. Pipe Dip.

This is a patent dip manufactured by the Standard Paint Co. Its principal ingredients probably are asphalt and candle tar pitch. The latter is a pitch obtained by distillation of animal fats. This coating has been used somewhat on steel pipes, but not long enough for a test of durability. As applied to cast iron it gives a coating very similar to asphalt coating—not hard, not brittle, not very glossy, not very tenacious.

Mineral Rubber Dip.

This is a dip manufactured by the Assyrian Asphalt Co. The process is not patented, but is secret. The appearance indicates that the compound is largely asphalt, and the coating is somewhat similar to asphalt coating, only duller in appearance. The dip requires a temperature of about 400° F. This dip has recently become very popular for steel pipes.

Varnishes.

There are many cheap varnishes made from tar, and there are also more expensive ones containing asphalt and other ingredients. These varnishes consist of some solid dissolved in a volatile carrier, which quickly evaporates, leaving the solid on the coated body. The engineers of the Metropolitan Water-Works have used a number of these varnishes in painting over the coal-tar coating, with the idea of filling up the pores in the coating. The writer has experimented with some of these varnishes:

(1) P. & B. Universal Paint, manufactured by the Standard Paint Co. This is to many a very familiar varnish, because it is not forgotten after having been once used. The solvent contains carbon disulphide, the odor of which is sickening to most persons. The coating seems fairly good after it is on, but the odor interferes with its use.

(2) P. & B. Ruberine, also manufactured by the Standard Paint Co. This varnish consists of "ruberoid" dissolved in naphtha. Ruberoid consists of California asphalt and candle tar pitch digested and vulcanized with sulphur. Ruberine dries rapidly and is hard to spread smoothly. It gives, however, a substantial rubbery coating.

(3) Tar varnishes. Two of these were tried, one an American and the other a Dutch product, imported by Paul A. Davis, of Philadelphia, and said to be much used abroad. The varnishes were thin, had the coal-tar penetration, and gave smooth, good-looking coatings.

It is evident that the use of varnishes would be very limited, unless it were found possible to use them as dips; their rapid evaporation seems to preclude their use in this way; but trial alone, and on a large scale, would settle this question.

Tests of Coatings.

Of course the only satisfactory test of coatings is actual use under known conditions. Small-scale experiments are often misleading and always inconclusive. Moreover, all coatings are so durable that it takes a number of years to form an idea of their relative value, and by that time something new is often favored on theoretical evidence. However, the small specimens used in the experiments above described were subjected to several tests.

(1) Test for brittleness. Most of the specimens were tested by hammering to see whether the coating was liable to fly off in handling of pipes. Allusion to brittleness has been made in describing the coatings.

(2) Test of porosity. It is known that tubercles start at minute holes in coating. It was thought that if acid did not injure the coating material itself, it would give a test of the porosity of coatings by attacking the metal through the pores. Specimens of coated iron were put in glass jars containing a mixture of one part muriatic acid and two parts water. At the same time samples of the coating materials alone were put into other glass jars with acid of the same strength. Great activity was immediately apparent in the case of the coated iron, and a disagreeable gas with a sweetish odor was evolved. The coating materials alone, on the other hand, were apparently not acted upon. Their appearance, and the appearance of the acid in which they were submerged, remained the same to the end of the test, which was almost as long as the test of the coated iron.

The coatings were all badly undermined, and all but a specimen of Sabin's japan peeled off in many places. The iron was dissolved to a depth of ¼-in. in places, especially at the corners. The estimate that was placed upon the specimens, beginning with the least injured, is shown by Table I.

TABLE I.—Acid Tests of Coatings for Porosity.

	Coating.	Time exposed, days.	Remarks.
1.	Sabin japan	55	Specimen said to have been rusty before being coated.
2.	Crude tar	55	
3.	Tar and linseed	60	No distinction possible.
	Alcatraz asphalt, pitch and linseed	60	
	Mineral dip (Assyrian Asphalt Co.)	55	
	P. & B. dip (Standard Paint Co.).	55	
4.	Alcatraz asphalt	55	
5.	All the varnishes	55	Totally destroyed.

There was only one specimen of each coating.

(3) Running water test. The specimens indicated in Table II. have been kept in running Boston water. Many tubercles have already formed on corners and on the rough fractured edges, but only a few* on the smooth large faces that formed parts of the inside and outside, respectively, of the pipes from which the specimens of iron were broken. The writer's estimate of the coatings is given in Table II.

TABLE II.—Results of Exposing Coatings to Running Water.

Coating.	Time exposed, years.	Remarks.
1. Tar and linseed.	2	Coating is smooth and in good condition, except for group of five ¼-in. tubercles.
2. Mineral dip.....	2	Few tubercles on large surfaces, but coatings rather earthy.
P. & B. dip.....	2	
3. Alcatraz asphalt.	2	Badly tubercled; covered with crumbling blisters.

There was only one specimen of each coating.

The samples indicated in Table III. have endured four months in running Delaware River water—whereby they

*See Report of the Cochituate Water Board, 1867-68, p. 17.

*This does not include the numerous tubercles, due perhaps to galvanic action, that were formed at many places along the copper wire wound around the specimens to suspend them by.

were scarcely tubercled at all, but received a heavy coat of mud—washings to remove the mud, and finally 17 months in running Boston water, where they still are. The specimens have only three to five incipient tubercles* and a few specks on the large surfaces, though there are a good many well-developed tubercles, as usual, on the rough edges of fracture, and around the copper suspension wire. In general appearance the writer would rank them as is Table III.

TABLE III.—Results of Exposing Coatings to Running Delaware River Water for 4, and Boston Water for 17 Months.

Coating.	Remarks.
1. Pitch.....	Coating still glossy.
2. Pitch and linseed.	
3. Pitch and linseed, painted with Dutch varnish.	
4. Mineral dip ..... P. & B. dip.....	Tubercles not more numerous than in the case of the foregoing specimens; surfaces rather earthy in appearance, and not smooth.
5. Dutch varnish...	Freer from tubercles than any of the other specimens; surface is earthy and friable, black powder being easily scraped off.

There was only one specimen of each coating.

The specimens in Table IV. endured the same treatment in Delaware water and subsequent washing off of mud, and were finally placed in a tank of water that is not often changed, where they have been about fifteen months. The tank has been used for much of the time for cement briquettes, and the water is hence very alkaline.

TABLE IV.—Results of Exposing Coatings First to Running Water and Then to Alkaline Water, Seldom Changed.

Coating.	Remarks.
1. Pitch.....	Good condition; few tubercles.
2. Tar covered with Dutch varnish.....	
3. Tar and linseed.....	
4. Alcatraz asphalt, pitch and linseed.....	
Tar.....	
5. Mineral dip..... Alcatraz asphalt & linseed (2 specimens).. Alcatraz asphalt, pitch & linseed (specimen)	In fair condition.
P. & B. paint (2 specmns) Dutch varnish.....	Few tubercles; coatings rather earthy; black will rub off.
6. Mineral dip (another specimen)..... P. & B. dip ..... Alcatraz (2 specimens)	Bad condition; many well-developed tubercles; also crumbling blisters.

There was only one specimen of each coating, except in the cases specially noted above.

Table V. gives a very rough idea of the relative cost of the various coating materials. The crude tar results are based on actual records and are believed to be reasonably close. The other results are mere estimates, based, in the case of the dips, on the results for tar; in the case of the varnishes on estimated covering capacity; and in the case of the Sabin japan on results for steel pipes.

TABLE V.—Approximate Relative Cost of Various Coatings.

Coating.	Approx. amt. required to coat one 48-in. pipe, galls.	Approx. price.	Cost of material, one 48-in. pipe.
Crude tar.....	3¾ galls[1]	$3.00 pr bbl. (52 galls)	$0.22
Pitch.....	5 "	5.00 " " "	.50
Pitch and linseed.....	.....	....	.70
P. & B. dip.....	20 lbs.....	45.00 per ton.....	.45
Mineral dip.....	20 "	75.00 " "	.75
P. & B. Univ. paint.	1½ galls.	1.00 per gall.	1.50[3]
P. & B. ruberine....	1½ "	1.00 " "	1.50[3]
Tar varnish.....	1½ "	.10 " "	.15[3]
Dutch varnish.....	1½ "	.25 " "	.40[3]
Sabin japan.....	1½ "	1.75 " "	2.60[3]

[1]About 30% of this lost by evaporation.
[2]Estimated cost of the coating applied as by a brush. Wastage might be excessive as dip, but the latter would be the only practical way for use on a large scale; hence the figures above are not strictly to the point.
[3]This coating requires a comparatively expensive plant and considerable skilled labor, which would largely increase the total cost.

Conclusions.

Should the Sabin japan prove by use to be as good as it appears to be, engineers would have to decide whether it were economical to add from 5 to 10% to the cost of pipes in order to prevent in part a deterioration, in the carrying capacity, which has been found as large as 20% in 16 years in even large pipes.† But the efficacy of the coating must be proved by several years of use.

As for the above tests, the tar compounds seem to have the best of them on the whole (barring the Sabin japan, which was tested only by acid), though the tests are too few and too short to serve as a basis for decided opinions. The writer would like to try roofing pitch on some pipes. He has considerable faith in the efficacy of thick, smooth coatings, such as it makes. The experiments show that only a thick coating will protect rough surfaces and corners. If the pitch proved too brittle to stand the handling of shipping and carting, it would not be impossible to have a portable coating outfit. The writer would also like to see a refined tar and linseed oil coating tried on the commercial scale. He would suggest that it would not be a very expensive experiment for a large city to try the several coatings on some line of its pipes and thus determine in a national way what coating was best for its water.

Rusty pipes will apparently not hold a coating. At one foundry were several 30-in. pipes having only little blotches of tar coating left on them. The writer was told that these pipes were coated only two years before, but were very rusty when coated.

The foundry scale which forms the surface of castings will protect the castings from rust for some time. Even when a casting is allowed to stand in a shower or two, only streaks of rust on top are formed at first. All chipped surfaces, however, quickly rust, and is is noticeable that coating over chipped surfaces is often quickly destroyed. Whether this is due to the surface being rusty before coating, or to a poor adhesion of the coating to even clean chipped surfaces, is unknown to the writer.

*A piece of pottery coated with Dutch varnish was not tubercled at all. This corresponds with the generally accepted idea that iron is essential to the formation of tubercles.
†See paper by Desmond FitzGerald, Mem. Am. Soc. C. E., Trans. of Am. Soc. C. E., Vol. XXXV., 1896, p. 241.

A MODEL ELECTRIC LIGHT AND POWER PLANT

(With full-page plate.)

We publish this week cuts showing the power house of the Queens Borough Electric Light & Power Co., located at the village of Far Rockaway, which is now part of Greater New York. The installation is thoroughly modern and exceptionally complete, and some difficulties met in erecting the building have been met in a novel and original manner.

The most notable feature in the construction of this plant is the type of foundations and floors used. The building is located close to the bulkhead of a salt-water inlet, in order that coal may be taken directly from vessels and that sea-water may be used for condensing. The ground here offered a very poor base for foundations, and it was necessary to excavate to a depth of 10 ft. or more to hardpan. Upon this stratum concrete footings were laid, 4 ft. wide, 18 ins. in depth, and running the entire length of the building. These bases are spaced 6 to 7 ft. apart, c. to c. A sectional plan and elevation of the foundations and floors is given in Fig. 1. Upon these strips of concrete brick piers 20 ins. square were built, spaced about 6 ft. apart and rising to within 8 ins. of the level of the boiler-house floor. A false floor was then built flush with the tops of the piers, and over the whole was spread a 2-in. layer of concrete. While still soft this was covered by a layer of expanded metal and then by another layer of concrete. Upon this was placed a second layer of expanded metal, and then the addition of 4 ins. more of concrete completed the floor. As will be obvious, the expanded metal is intended to furnish the necessary tensile strength for the underside of the floor. It is possible that the floor would be still stronger if a layer of expanded metal had also been placed near the upper surface, as the floor is subjected to considerable negative bending moments at points over the piers. It may also be noted that expanded metal was used instead of bonding stones in the construction of the brick piers themselves, and that the floor was thoroughly bonded into the walls of the building.

The first floor, which we have just described, serves in that part of the building shown on the right-hand side of the plan, as the boiler-room floor, and is 2 ft. above high tide level. In the left-hand side of the building this floor was used as a base upon which to build the engine foundations. The engine-room floor is built in the same manner as the lower floor, and is level with the tops of the engine foundations, by which it is supported by means of I-beams, and into which it is bonded.

As first designed, these floors were to be supported by heavy brick arches, which would have entailed great expense, both because of the more expensive materials employed and the greater amount and higher price of the labor required. The present floor has proven satisfactory in every way, and shows no tendency to crack or crush even when subjected to severe strains by the moving of heavy machinery about upon it.

The foundations of the walls of the building are also of concrete, and are brought up to the street level. The building has a self-supporting steel frame with brick walls, the roof being carried on steel trusses, covered with tongue-and-grooved plank, and finished with an asphalt and slag covering.

The mechanical and electrical part of the plant is worthy of attention for its completeness. Pains have been taken to secure efficiency and to minimize, as far as possible, the labor required for operation.

Coal is taken direct from vessels lying alongside the bulkhead, and hoisted to the top of a steel tower, where it is dumped into cars, weighed and thence run into a 500-ton storage pocket occupying the upper part of the boiler-room. This amount is considered sufficient to safely operate the plant during such periods of the winter as navigation may be closed by ice. From this pocket the coal is drawn by coal chutes, and delivered to the American automatic stokers.* These are of the type in which the coal is fed into the furnace by means of a screw, and are installed in order to be able to use the cheapest grades of coal and to secure smokeless combustion. Air pressure is maintained in the ash pit by a Buffalo Forge Co. blower, operated by an independent Westinghouse engine located on the boiler-house floor.

There are three Babcock & Wilcox water-tube boilers, with a rated capacity of 225 HP. each, and designed for a working pressure of 150 lbs. The boilers are set in one single and one double setting, and sufficient room is provided in the boiler-house to double this installation when necessary.

After leaving the boilers the gases pass through a Greene fuel economizer of 160 tubes, and are discharged into a short steel stack by an exhaust fan direct-connected to its own engine. A second fan and engine are provided as a reserve. A bypass is placed so that the economizer may be cut out when necessary.

The boilers are fed from either one of a duplicate set of steam pumps which take their supply from the street main and force it through a feed-water heater located on the main exhaust line between the engines and the condenser, and thence through a second heater using the exhaust from the pumps and the auxiliary engines. The water then passes through the economizer and enters the boilers at a temperature approximating 300°.

The feed-water may be by-passed around the exhaust steam heaters, so as to enter the economizer direct from the pumps, but this is found impracticable, as it causes moisture to condense on the economizer tubes. The moisture takes up sulphur dioxide from the furnace gases, forming sulphurous acid, which rapidly corrodes the pipes. The relative inefficiency of the small auxiliary engines does not operate against the efficiency of the plant, as the exhaust from these engines furnishes just about the amount of heat required to heat the feed water up to the temperature at which it may enter the economizer without producing injurious results. The temperature of the gases leaving the economizer is near 300° F.

The exhaust steam, after passing through the first feed-water heater and being partly condensed, is led to one of two Blake vertical twin air-pumps and jet condensers, each capable of handling 20,000 lbs. of steam per hr., and using salt water injection. The exhaust piping is so arranged as to permit of running either one or both of the condensers, or of running non-condensing, for which purpose an automatic relief valve is placed in the free exhaust line leading up through the roof.

The main engines are Greene-Wheelock cross-compound condensing, with Hill valve-gear, using steam at 150 lbs. and running at 150 r. p. m. Each of the two engines is to develop 400 HP. at its most economical point of cut-off, with a maximum of 625 HP. Between the high and low pressure cylinders is located a reheating receiver with 1½-in. seamless-drawn brass tubes. In addition to these engines there is a Payne tandem compound engine, used to drive two 120-light Brush arc machines, two Westinghouse vertical compound engines to drive the duplicate set of exciters, a Lidgerwood hoisting engine to hoist the coal from vessels, and a Westinghouse air brake pump, with a storage reservoir, from which pipes are run to convenient outlets for the attaching of hose for cleaning out machinery. All the engines are provided with automatic lubricating piping systems, with provision for reclaiming and filtering the oil.

Mounted directly on the shaft of each of the

*Described in Engineering News, Jan. 2, 1896.

main engines is a 300-K-W., 2,500-volt, rotary field, two-phase, alternator, made by the General Electric Co. Its full load efficiency is 93½%, and it is guaranteed to carry a 25% overload for two hours. The exciters, mentioned above, are two 25-K-W., 125-volt General Electric machines, each being of sufficient capacity to excite the entire plant.

The company will supply direct current for operating a part of the Long Island R. R., and for that purpose will install two 100-K-W., oil-insulated, step-down Westinghouse transformers,

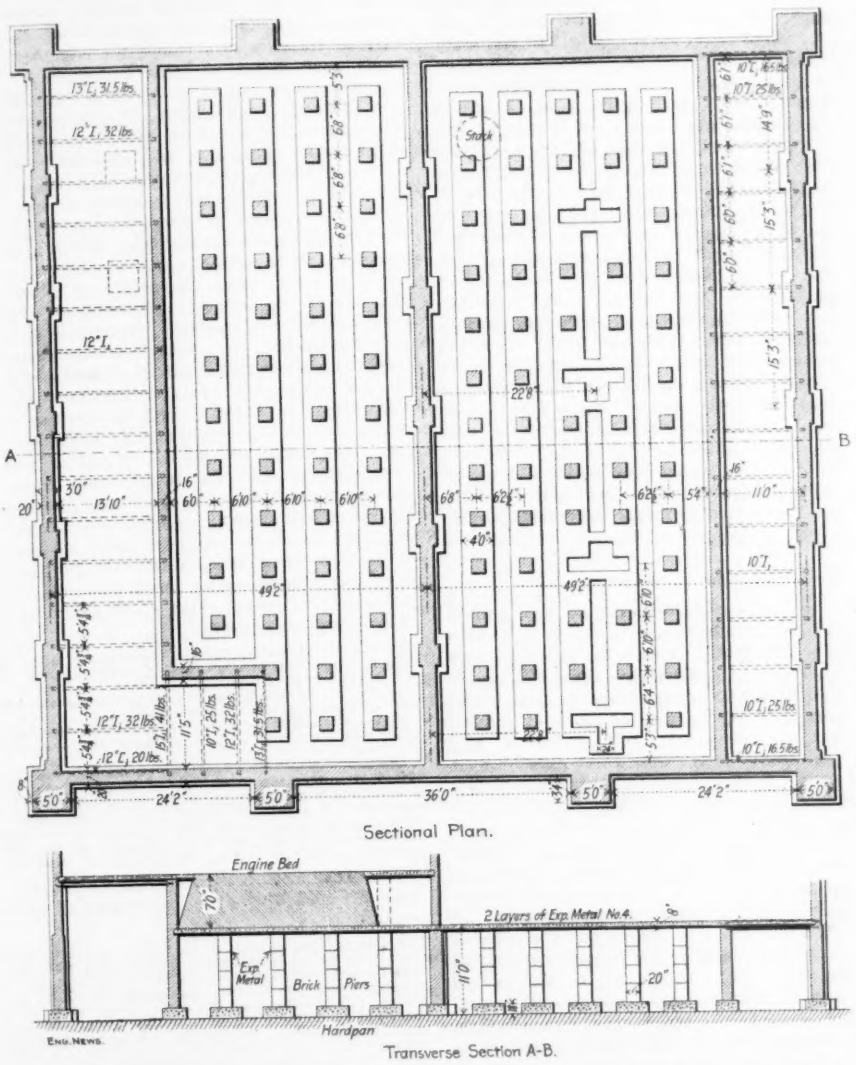

FIG. 1.—PLAN AND SECTIONAL ELEVATION OF FOUNDATIONS AND FLOORS, QUEEN'S BOROUGH ELECTRIC LIGHT AND POWER CO.'S POWER-HOUSE, FAR ROCKAWAY, L. I.

which will supply a 200-K-W. Westinghouse rotary converter running at 720 r. p. m., and delivering direct current at 575 volts. To supplement the transformer and give a regulation and economy otherwise impossible to attain, the company has installed in a building provided for that purpose at Hammers (situated about 4½ miles from the power station), a storage battery, built by the Electric Storage Battery Co., having a guaranteed capacity of 25 amps. for 7 hrs., and a maximum discharge rate of 100 amps.

In the light distributing system, large transformers have been placed, wherever possible, in order to reduce core losses to a minimum. All the circuits are protected by Wurtz non-arcing-metal lightning arresters.

About 18,000, 16-c. p., 108-volt, incandescent lamps, and 171 arc lamps are now supplied. The material from which this article has been prepared was furnished by Messrs. Sanderson and Porter, of 31 Nassau St., New York, who were the engineers and contractors for the entire plant.

OPERATION OF THE ELECTRIC STREET RAILWAYS OF HAMBURG.

In "Advance Sheets of Consular Reports," for Sept. 1, 1899, U. S. Consul Hugh Pitcairn, of Hamburg, Germany, describes the electric street railway system of that city, the oldest and most complete on the Continent. As this railway was built on the Thomson-Houston system, some account of it will be interesting to our readers.

The road was built by the Hamburger Strassen-eisenbahn Gesellschaft, with a capital of 21,000,000 marks, or $4,904,000. It is of the overhead trolley type and operates 500 motor cars and 400 "smoking-cars," or trailers. On account of the narrow streets, poles were prohibited in many places, and the span-wires supporting the conductors are anchored to the houses. For this accommodation the company paid the houseowners the cost price of the poles avoided; $11.20 for a one-wire anchor, and $15 for a two-wire anchor. Where poles are used, they are neat in appearance and also serve as electric-light posts. Where the street was too narrow for two tracks, only one was laid; but to avoid loss of current, a double contact-wire was suspended.

The smoking-cars referred to are simply the old horse-cars utilized as trailers; and about every third trolley car has one of these trailers attached to it. It should be stated that about ten years ago, and before trolley cars were thought of, the Hamburg Electricity Works obtained a concession from the State for a monopoly in supplying "electric currents" and appliances on the public highways. While this was intended only to apply to electric lights, it was not so specified, and the railway company had to arrange with the old company accordingly, and the latter enlarged its plant so as to supply the current necessary. The Hamburg Electricity Works pays to the State of Hamburg 20% of its gross income for the monopoly; and the electric works charges the street railway company 12½ pfennigs, or 2.97½ cts., per K-W.-hour, for electric power furnished. The State of Hamburg refunds to the railway company 20% of this price, leaving the net cost 2.38 cts. per K-W. hour.

As compensation for the use of the streets the railway company pays the State one pfennig, or 0.238 ct., for each passenger carried. As the average fare for each person is 2.74 cts., the State receives 8.7% of the gross income of the railway company. In addition to this the railway company must keep up the paving between its rails and for about 12 ins. outside of each track. The company is not at liberty to fix its own fares, but must forward passengers according to a tariff fixed by the Board of Public Tariff and approved by the Senate. All lines are divided into zones of 2,000 m., or 1.24 miles each; for the first two zones, or 2.48 miles, the fare is 2.38 cts.; but for each two zones or parts thereof it is 1.19 cts.; or 10 and 5 pfennigs in the two cases. The tickets issued differ in color, according to the zones to be traveled over, and in price they run up to 20 pfennigs, or 4.76 cts., for a six-zone distance. The zones are numbered on the sides of the ticket, and the proper number is torn out by the conductor, as a check on the distance paid for. As a check on the honesty or carefulness of the conductor, a "comptroller" is liable to board the car anywhere and count the passengers and compare them with the list of tickets sold, which the conductor must fill out at the end of every two zones. If there is a discrepancy the passengers must show their tickets, etc, and the passenger having no ticket must pay again, whether he says he has or not, and the conductor is fined 1 mark, or 24 cts., for the first offense; 3 marks for the second, and for the third offense he is at once discharged.

A peculiar commutation-ticket system is in operation. As many people use the cars several times a day, these tickets are divided into two classes. The first class entitles the holder to use any one line in both directions as many times as he pleases, including Sundays. The second class of commutation-tickets are good for use on all lines and as often in a day as required. These tickets are good for 3 to 12 months; and the price is so low that if the ticket is used three times a day, the fare for each trip is less than one cent. In addition to this, combination tickets are issued good for one line and part of another line; the tickets for school children cost only 0.95 cts. per trip.

The trolley cars seat 20 to 28 persons, and 4 passengers are allowed on the front and 5 on the back platform. As soon as every place is taken, however, the conductor lowers a sign of "Besetzt," or "occupied," and no one is allowed to come aboard until room is provided by some one leaving the car. This rule is very strictly enforced; and if the police detect a conductor carrying one more than his quota, the conductor is fined 3 marks (72 cts.), to be deducted from his wages and paid over to the police board. If the comptroller detects a surplus of passengers the conductor is fined the same amount and the money goes to a charity fund divided once a year among needy employes of the company.

Both trolley cars and trailers have both hand and electric brakes; but there are no car-fenders, as the company claims that it has not yet found one adapted to this use.

THE "NORTH STAR" IS THREE SUNS, says the star photo-spectroscope of the Lick Observatory, according to late reports from that place. The human eye, when applied to the telescope, cannot detect these separate suns, 255,000,000,000 miles from the earth; but the camera, or photo-spectroscope, applied to the 36-in. refractor, shows three suns; one revolving about the other in four days, and these two revolving about a third. With this telescope and its spectroscope 14 multiple stars have been found. The same appliance is used in determining the velocity of stars; and it was found, a short time ago, that Polaris was approaching the earth with a velocity of 16 miles a second.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXII. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

It is a pity that the demands of those who represent the interests of labor, or who assume to do so, cannot be more frequently tempered with wisdom. A striking example of the lack of good sense on the part of labor union representatives has just been made public in New York, where a committee of the Federation of Labor has demanded that the Superintendent of Public Works, Mr. John N. Partridge, shall enforce the State eight-hour law in the employment of lock tenders on the State canals.

The work of a canal lock tender cannot, by any stretch of the imagination, be described as arduous. His duties are exhausting neither to the mind nor to the body. In fact, on a large proportion of the State canals it is entirely possible for a lock tender to enjoy goodly periods of sweet and refreshing slumber during the hours when he is technically engaged in the service of the State. If he be not of a somnolent temperament, he can indulge in other labor or recreation in the intervals between boats. Golf might be ruled out as likely to take him too far from the scene of his duties; but quoits, solitaire, and numberless other innocent sports could ward off ennui, and give congenial employment to hand and brain. If industry is his forte, there are various handicrafts which can be pursued, with both pleasure and profit, and without interference with his regular duties. Moreover, although for 12 hours of the day a man is somewhat closely confined to one spot, this confinement lasts only for the season of canal navigation. During some five months of the year the lock tender is free to roam where he will.

Under these circumstances it is exceedingly difficult to arouse deep sympathy for the lock tenders, even at the present time, when they are required to be at their posts for 12 hours out of the 24. It is vastly easier to feel sympathy for the taxpayers, who, when the 8-hour plan is put into force, will have to go down into their pockets to increase by 50 per cent., according to Col. Partridge, the annual expenditure for lock tending on the State canals.

The loss to the taxpayers, however, is the least of the injuries which are caused by the injudicious enforcement of the eight-hour law. The eight-hour working day, for example, is one of the reforms in which the labor organizations are most interested. There is reason in the claim that when a man is engaged in hard, exhausting and debilitating labor the year round, without intermission, and at the pace set by the machinery of modern production, eight hours is sufficiently long for a day's work. There is reason, we say, in this claim; but there is no reason at all in the claim that the same rule should be applied to all labor, and that a man doing light and healthful work, and employed only a part of the year, should be compelled to work only 8 hours out of the 24. Every such instance of injudicious application makes enemies for the eight-hour movement, and delays its application to the classes which really need it.

Again, labor is deeply interested and strongly committed to the policy of State and municipal ownership and operation of natural monopolies; and in this it is in accord with the general trend of modern thought. Right at the outset, however, we are met by the argument of those who declare that on all such work, labor will be so expensive as to bankrupt the State or municipality which engages in it. Every such piece of foolishness as the application of the eight-hour law to lock tenders is valuable ammunition for those who would keep monopolies in the hands of private corporations. It is because of plain and easily understood facts like these that we believe the action of the Federation of Labor committee in this matter to be an injury to the real interests of labor.

Among the committee reports at the annual meeting of the Roadmasters' Association, which we publish this week, is one in which we are gravely informed of experiments upon the expansion of steel rails with temperature changes. These experiments showed, we are informed in the report, that the coefficient of expansion was greater in light rails than in heavy ones. In view of the statement of the committee that it "labored under the disadvantage of having no means at hand of making entirely accurate measurements," our faith in the permanence of physical constants will hardly be shaken. The committee winds up its report with the grave recommendation that a new committee be appointed "to report definitely upon the difference in expansion of 30-ft. and 60-ft. rails." We venture to add the suggestion that such a committee should discard all the new-fangled scientific measuring instruments and measure the length of the rails before and after heating by the time-honored method of laying on the hands side by side with thumbs extended.

CONCERNING LIQUID AIR COMPANIES.

The liquid air industry is in a very *promising* condition at present, if we may judge from the numerous promises of future performance which we read in advertisements in the daily newspapers, in circulars and pamphlets, and in typewritten letters that are being widely distributed over the country. There are already at least three companies organized with large capital (on paper), each of which is spending a large amount of money on printers' ink. Their names, addresses and nominal capitalization are as follows:

Consolidated Liquid Air and Power Co., Walter H. Gates, Fiscal Agent, $10,000,000, 22 Exchange Place, Boston, Mass.; Liquid Air, Power and Automobile Co., Thomas Sewall, Treas., $5,000,000, 186 Devonshire St., Boston, Mass.; and American Liquid Air Co., $10,000,000, 1 Broadway, New York city.

Besides these, Mr. Chas. E. Tripler, of 121 West 89th St., and the General Liquid Air Co., of 220 Broadway, New York city, have each built plants for the production of liquid air, which have been fully described in these columns, and each of them, we understand, are doing more or less in the way of interesting investors in their respective enterprises, although they are not hunting for them with a brass band.

From their printed advertisements, circulars, etc., together with other information in our possession, it appears that each of these companies claims to own a practical monopoly of the business of liquid air manufacture, and of the patent rights under which only it is possible to manufacture liquid air cheaply, and to utilize it with economy. Neither one of the three first-named companies, so far as we are aware, gives, in its printed publications, any information of a technical nature concerning its methods of manufacture, nor any dates or numbers of its patents. Hence an engineer has no basis upon which to form a judgment as to whether either one or all of these companies own any valuable patent rights, or whether they have ever made any liquid air at a cost which would permit of its being used on a commercial scale for power or for any other useful purpose.

Technical information, however, is not desired by the lay reader of promoters' advertisements, for he would not understand it. What he does understand, or thinks he does, are claims, promises, offers of stock whose par is $10 at $3 per share, etc. These the promoters of liquid air companies give him in full measure. The only thing that may puzzle him, and make him doubt to which one of the several companies he shall send a check for his subscription is the apparent conflict of statement in their several prospectuses, as to which one of the companies is going to be the giant monopolist, owning the only cheap and practical method, etc. We quote below some of the claims of the first three companies above named, but we cannot pretend to judge which one makes the most extensive claims, nor which one gives to the investor in its stock the most (or least) hope of eventual performance of its promises.

One of the Boston companies advertises in the daily press as follows:

> Liquid air produced by our methods so much cheaper than by any other process that its cost is merely nominal and beyond competition.
> Liquid air successfully used as power by the first and only practical devices ever invented.
> Those who were present with our Mr. Code at recent trials are convinced and enthusiastic over the wonderful results.
> Owning exclusively the right to manufacture and use liquid air under the inventions of Messrs. Code, Knudsen and Chase, The Liquid Air Power & Automobile Company has before it a field unlimited in extent, profits never before equalled in any field, and will make more money for its stockholders than was ever realized from any other investment, whether mining, commercial or inventive.

The other Boston concern, the Consolidated Liquid Air and Power Co., in a printed pamphlet, says:

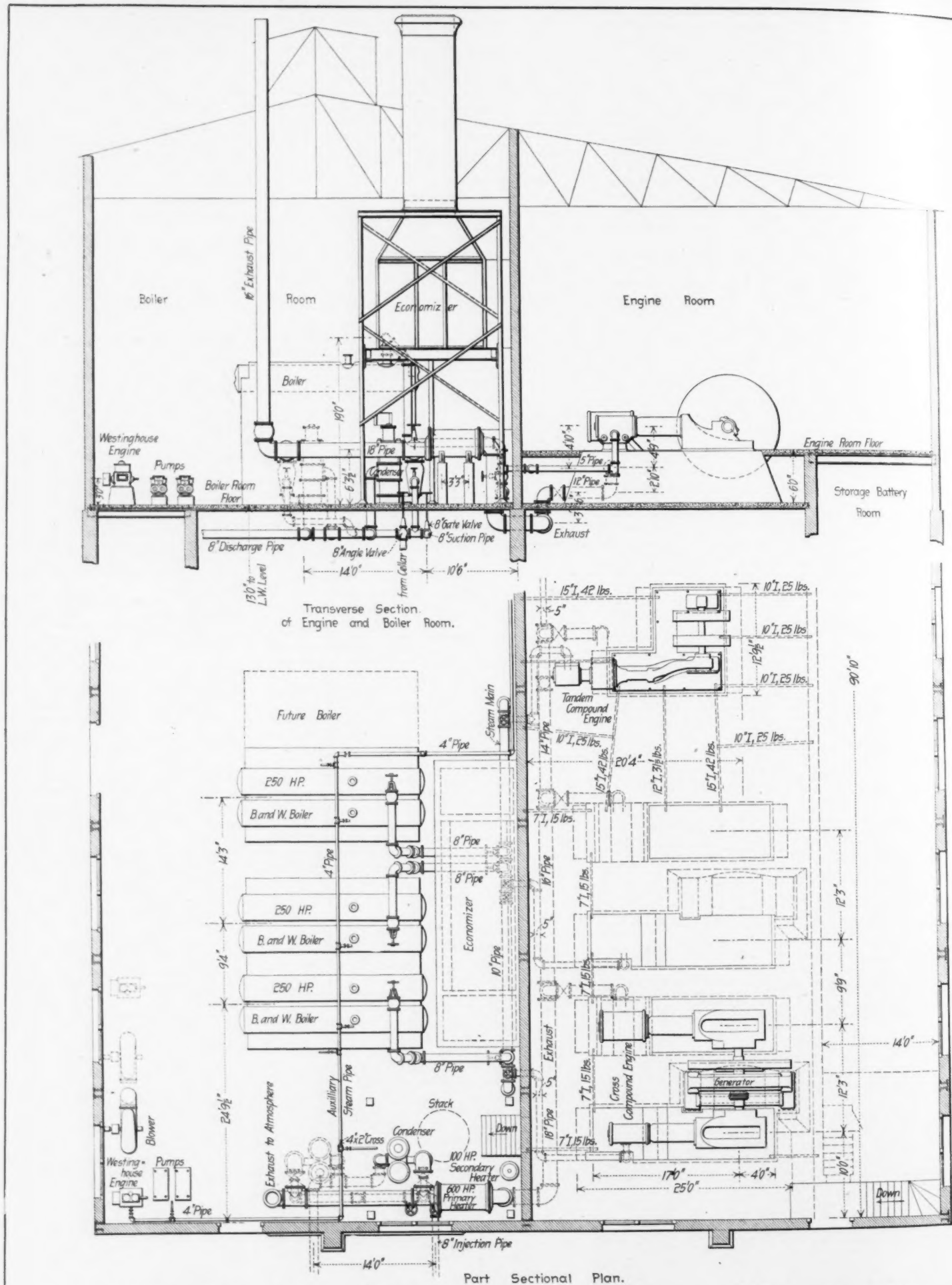
> It proposes to furnish to the public a safety receptacle for transporting, distributing or retaining the above. It will furnish valuable by-products for agricultural and industrial uses. It controls improvements which, it is believed, will revolutionize the use of compressed, congealed, liquefied or rarefied air as a motive power for civil uses, such as mill power, propulsion, refrigerating, ventilating, drying, etc. And, in addition, it has what no other company claims to possess, the process for which applications for letters patent are pending for the use of compressed, congealed and liquefied air as an explosive, which will in itself change the present methods used in mining operations.

Mr. Gates, the "Fiscal Agent" of the Consolidated Co., in a circular letter, says:

> Liquid air, as demonstrated by Mr. Rouilliard, the inventor, I believe is far superior to any other put before the public. The Consolidated Liquid Air and Power Co. will manufacture liquid air at less cost than any other now in the market.

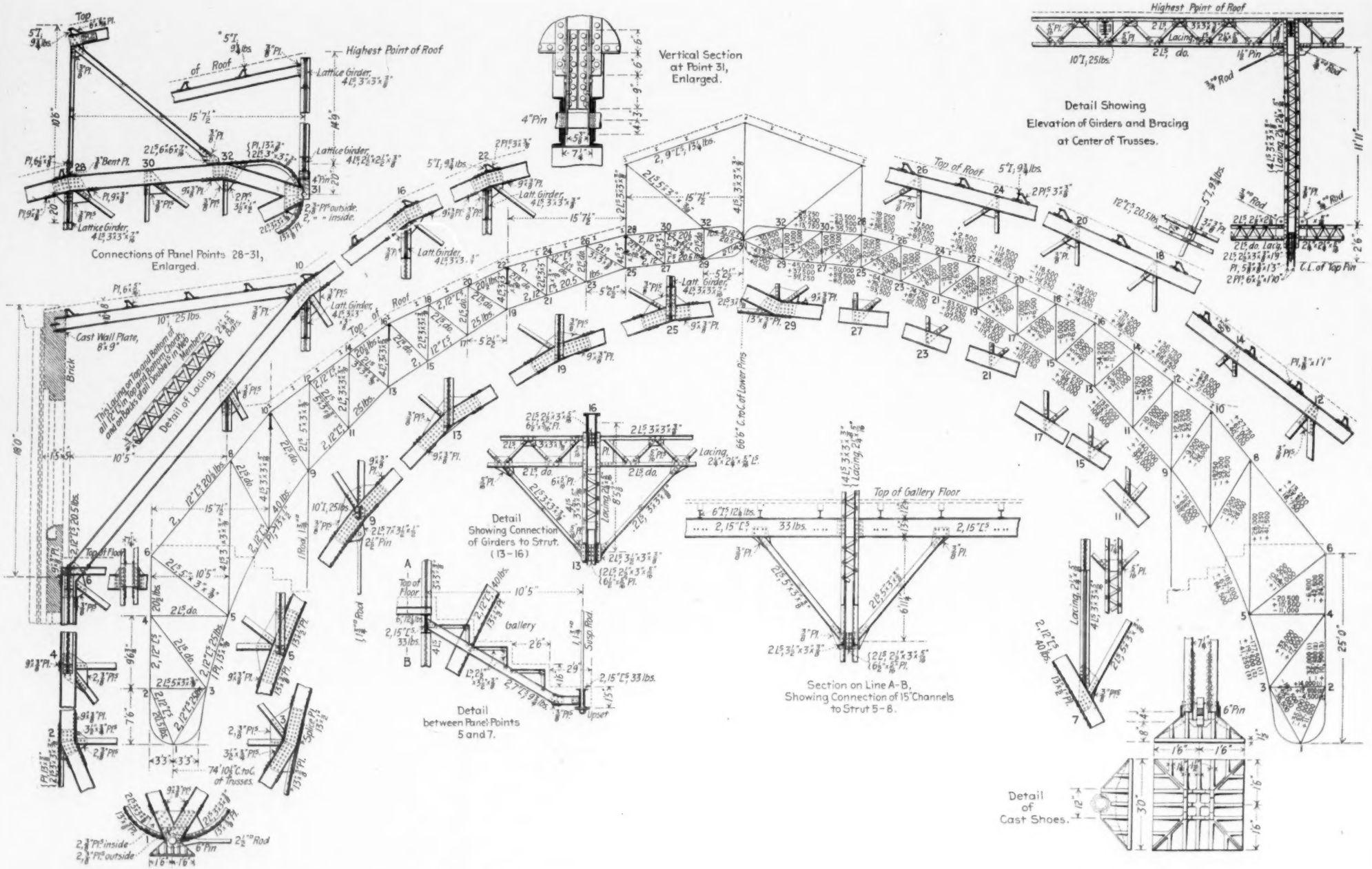
The American Liquid Air Company prints in pamphlet form an "Address" delivered by the president of the American Liquid Air Co., at a special general meeting of stockholders, held on Aug. 11, 1899, from which we abstract the following:

> The Ala system * * * comprises a self-intensive work method which differs in principle from any of the other systems I have mentioned and can be scientifically demonstrated to be the only possible way of obtaining intense cold by the expansion of compressed air without encountering great mechanical difficulties or having to put up with a very low yield. The Ala method, moreover, does not require any high degree of initial compression; while the apparatus employed is of a very simple character and can be very cheaply constructed. These features enable us to guarantee a much lower cost of installation and maintenance and a much greater yield of liquid air for the power employed than can be offered by any other system. This is what I mean by saying we have a virtual monopoly of the whole liquid air business. No expert who may be employed to adv.se any firm, corp ration or government department as to the erection of a plant for liquefying air will, if he be capable and honest, hesitate for a moment in recommending the Ala method as being far in advance of all others. * * * * Last month a group of leading business men in Pittsburg, Pa., after careful considera-



POWER-HOUSE AT FAR ROCKAWAY, L. I., QUEEN'S BOROUGH EL. LIGHT & POWER CO.

Sanderson & Porter, 31 Nassau Street, New York City, Engineers and Contractors.


Connections of Panel Points 28-31, Enlarged.
Vertical Section at Point 31, Enlarged.
Detail Showing Elevation of Girders and Bracing at Center of Trusses.
Detail Showing Connection of Girders to Strut. (13-16)
Detail between Panel Points 5 and 7.
Section on Line A-B, Showing Connection of 15" Channels to Strut 5-8.
Detail of Cast Shoes.
Detail of Lacing.
Highest Point of Roof
Top of Roof
Top of Gallery Floor
Cast Wall Plate, 8"x9"
Brick
Lattice Girder, 4 L's 3"x3"x 7/16"
Latt. Girder, 4 L's 3"x3"x 3/8"
4" Pin
6" Pin
2 1/2" Rod
1 1/8" Rod
Susp. Rod
Gallery
Upset
Splice Pl.
Lacing
74' 10 1/2" C. to C. of Trusses
66'6" C. to C. of Lower Pins
25'0"

STRAIN SHEET AND STRUCTURAL DETAILS OF STEEL ROOF ARCH FOR THE CHICAGO "COLISEUM."

E. C. & R. M. Shankland, Chicago, Ill., Engineers.

Pittsburg Bridge Co., Pittsburg, Pa., Contractors.

tion of all the liquid air companies now before the public, selected our company as having by far the most practical and advantageous method; the result being that they have entered into a contract with us and have formed the Pennsylvania Liquid Air Co., to operate the Ala system in Western Pennsylvania on terms which will give us a very large profit. Indeed, so far as I have been able to learn, we are the only liquid air company that is doing actual business; the others that exist seeming to confine their efforts to lectures and demonstrations for reports and illustrations in the newspapers and magazines.

The printed matter in the several circulars, prospectuses and advertisements of the three companies contains some interesting reading. That of the American Liquid Air Co. is chiefly historical and scientific, and contains little, if anything, to which an engineer could take exception, although it may be too sanguine in its prediction that the "great air power companies will ere long have no option but to use liquid air as the primary form of the stored energy they require."

A circular of the Liquid Air, Power and Automobile Co. has a cut of a motor wagon which is claimed to "weigh less than 300 lbs., including the motor itself and liquid air to run over 100 miles." The cut was apparently made by a draftsman whose object seems to have been to conceal the actual mechanism by which the vehicle may be driven, but as it is stated that "five of these carriages will be completed in about four weeks for exhibition purposes," we hope we will have an opportunity to illustrate one of them as soon as it actually runs 100 miles on a single charge of liquid air.

For really interesting liquid air literature, however, we give the palm to the Consolidated Liquid Air and Power Co. We advise those of our readers who are interested to drop a postal card to Mr. Walter H. Gates, Fiscal Agent, No. 22 Exchange Place, Boston, and ask for a copy of the little pamphlet on "Liquid Air." It is a real gem. Here are a few extracts:

> He (Mr. Rouilliard) has found from practical experience that in order to obtain the best results from compressed air, that portion must be eliminated which renders compression difficult and expensive, and the basic principle upon which he proceeds is the demagnetizing and separating that portion of the air and compressing the balance.
>
> Mr. Rouilliard, whose inventions produced, besides liquid air, fluids containing in compressed form most of the chemical values of the air.
>
> One of the greatest drawbacks to the manufacture of liquid air has been moisture, which condenses in the cylinders and affects the stroke of the piston. All this has been obviated by Mr. Rouilliard by drying the incoming current of air by passing it over an electric crater, driving away not only the moisture, but also demagnetizing and disintegrating the air of its oxygen, thus producing a great increase in the force and elasticity of what is compressed, and avoiding the troubles above referred to.
>
> The Consolidated Liquid Air & Power Co. has secured and is securing a great number of idle water powers that actually run to waste. It will convert that power into electricity and use it in conjunction with compressors. The electricity will demagnetize, deoxydize, and also furnish the power to compress the air; it will supply the heat, and the chemical action required to disintegrate the air; the electrically activated compressions will manufacture the various fluids from the component parts of the air; and the product will be either the ordinary so-called liquid air, or, when wanted, concentrated nitrogen, concentrated oxygen, or, if desired, admixtures of the above with other fluids or liquids.

"Demagnetizing air," "drying it by passing it over an electric crater," and "electrically activated compressions," are terms which are quite new in technical literature. They remind us of the "polar and depolar forces" of the late lamented Keely. But as Mr. Keely used these, and many other terms unknown to science, with great success in extracting money from credulous investors, we have no doubt Mr. Gates' company is fully justified in using them for a similar purpose. We have not the slightest intention of reflecting upon Mr. Gates himself. He honestly believes the stock of his company is a good thing, "for he, himself, has said it." In a letter to one of our subscribers, dated Aug. 19, he writes:

> I would urge you and your friends to make an investment in this, as the price is soon to be advanced, only a limited block to be sold at this figure. I certainly believe in the value of the stock as an investment, or I should not handle it.

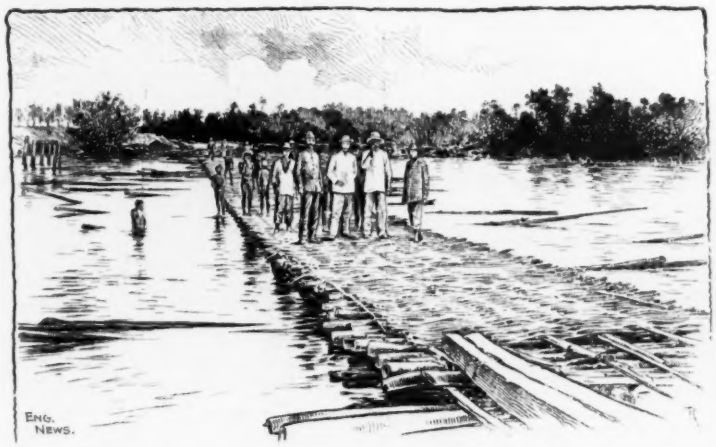
On Aug. 23 Mr. Gates writes:

> I take the liberty of writing you again, to notify you that the first block of 50,000 shares is very nearly exhausted, and the second block will be put on the market at an advanced price.

The stock of the Liquid Air, Power and Automobile Co. is also booming, according to the company's advertisements. The quotation in the original circular gives $2.50 as the price of a share of the par value of $10; more recent advertisements offer 60,000 shares at $3, and it is announced that on Sept. 16 the price will advance to $4. We have no doubt that the advance is quite warranted by the cost of the extensive advertising which the company is doing.

The moral of all this seems so plain that it can hardly fail of comprehension. Liquid air is now the subject of a popular craze, just as acetylene was two or three years ago, just as the X-rays, aluminum production, electric motors and compressed air have been at various periods. These are the harvest times for promoters. A sucker is born every minute, and some of the school can generally be induced to swallow the bait. We are well aware that a large number of inventors and engineers all over the world are and have been for some time honestly at work on the problem of liquid air production on a commercial scale. The practical success of any of them is yet to be demonstrated, and after practical success has been attained it will then remain to be seen whether any patents can be secured that will not be easily evaded by competitors.

An investment in the stock of a liquid air exploiting company might possibly be judicious, if it were made on the strength of a report by a competent engineer and a competent patent attorney employed by the investor himself. An investment in liquid air stock without such precautions is at the best to engage in a blind pool, and at the worst is to be duped by professional swindlers.



FLOATING BAMBOO BRIDGE OVER ILOILO RIVER, AT MOLO, ISLAND OF PANAY, P. I.
Built by B. F. Cheatham, Major, 1st Tenn. Vol. Infantry, June, 1899.

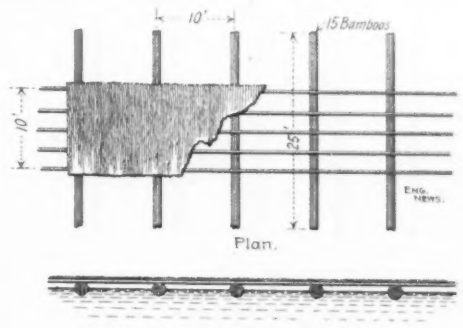
LETTERS TO THE EDITOR.

A Floating Bridge in the Philippines.

Sir: A floating bridge recently constructed by the American Army in the Island of Panay, has proven very satisfactory, and, as it possesses some unusual features, I send you a short description of its construction, in the hope that it may prove of interest to some of your readers.

The Ilo Ilo River at Molo is 200 ft. wide, 20 ft. deep, and has a difference in elevation at high and low tide of 3½ ft. The orders were to "build a bridge sufficiently strong for infantry and light artillery to cross; to build it quickly and cheaply." As there was no other material available, it was decided to use bamboo exclusively, and in the entire structure nothing else was used—not even a nail or piece of wire. Long pieces of bamboo were assembled in bundles of 15 and tightly bound with rattan. These bundles supplied the buoyancy for the bridge, and were placed 10 ft. apart, parallel to the current. They were held in this position by four stringers, which were securely lashed to the bundles so as to form a foundation for the roadway, 10 ft. wide. On these stringers were placed small bamboo, cut 10 ft. long, each piece being tied to the stringers by the invaluable rattan. Over these poles was laid a rough matting woven from split bamboo, which made an even surface strong enough to support a horse.

A sufficient quantity of bamboo was not on hand at the start, and the work was delayed somewhat in consequence, but the bridge was completed in four days by ten native workmen. The total cost for material and labor was $125. The banks at the place selected were 1½ ft. higher than the water at high tide. In order to allow carts to cross at all times, aprons were made of bamboo, one end fastened to the bank and the other allowed to slip along two pieces of plank, placed on the bridge for that purpose. The bridge was guyed so as to allow it to rise and fall with the tide.



Plan and Section of Molo Bridge.

The success of this bridge would seem to solve a problem here, and our experience shows conclusively that with plenty of bamboo on hand a regiment can cross any river here in four hours' time.

B. F. Cheatham,
Major, 1st Tennessee Volunteer Infantry.

Molo, P. I., July 7, 1899.

High Lift in Canal Locks Considered in Connection with the Volume of Traffic.

Sir: In the many different schemes for new canals and improvements of existing waterways which you have of late years placed before your readers, very little attention appears to have been devoted to the important question of the intervals between boats, upon which depends the tonnage capacity of the canal.

More attention has been paid to decreasing the time taken in passing through the whole length of canal, hence the universal tendency towards concentration of "lift." As an example, suppose a canal to be six miles in length with four lift locks of 15 ft. lift each, a boat can traverse the reaches in one hour, and with 15 minutes to each lockage, makes the total time of passing two hours; the interval between the boats would be 15 minutes, and the capacity of the canal 96 boats in 24 hours. Should the location of this canal be changed and the four 15-ft. lifts

concentrated in one lift of 60 ft., a boat could traverse the reaches in one hour, and say 20 minutes for the lockage; there would thus be a gain in time in passing through the canal of 40 minutes, but in place of 15-minute intervals between boats, and a capacity of 96 boats a day, we now have 20 minutes interval and only 72 boats a day.

The writer has assumed, without fear of contradiction, that the high-lift lock, whether pneumatic, hydraulic or mechanical, cannot make a lockage in as short a time as one of one-quarter the lift; and each minute lost in lockage at any lock on the system directly increases the interval between boats, thereby having an enormous effect on the yearly capacity. The time lost in operating a high-lift lock is not so apparent in the actual raising or lowering of the vessel in the chamber, but does make itself very apparent in the additional precautions necessary in handling large vessels entering and leaving the lock.

Much has been written about the economic lift of canal locks relating entirely to cost; it appears to the writer that the lift of locks of a system should be that through which a boat, of predetermined size, could be locked most rapidly, making the lift as great as is compatible with rapid handling of vessels and rapid repairs in case of accident to the structure. The question of cost may then be considered in determining the dimensions of the lock chamber, the number of boats taken in at a lockage being a direct factor in the tonnage capacity of the canal.

The Welland Canal was designed with locks having a lift of 12 or 14 ft., and great difficulty was experienced at the Niagara escarpment in obtaining a sufficiently gradual descent to admit of the 14-ft. lift being adhered to, and also a reasonable extent of reach between each lock. Had the more modern design been adopted and a high-lift lock placed at the escarpment, the writer does not hesitate to state that the efficiency of the canal would not be equal to what it is at present.

There appears to be certain points of resemblance between railways and canals. On railways the express and freight are distinct services, and each thoroughly well thought out; on canals too much attention has been paid to speed between termini, and not sufficient to the volume of traffic. "Subscriber."

Kirkfield, Ontario, Sept. 2, 1899.

The Manchester Meeting of the Iron and Steel Institute: August 15-18, 1899.

Sir: It has been my privilege and pleasure to attend, as a representative of Engineering News, the annual meeting of the Iron and Steel Institute of Great Britain, presided over by its President, Sir William C. Roberts-Austen, the Chief Chemist of the British Mint, and the successor in this office of such famous men in the annals of iron and steel as Henry Bessemer, Lowthian Bell, C. William Siemens, Bernhard Samuelson, James Kitson and David Dale. The institute has over 1,500 Ordinary Members, and it is intellectually and financially a strong body of men; and it may also be classed as an aristocratic body, for it carries on its rolls the names of the Queen of England, the Prince of Wales and the Kings of Belgium and of Norway and Sweden. This autumn meeting was held in Manchester, with an attendance of about 300 members, besides visitors, and the place of meeting was the grand banquet room in the Town Hall, ample in its proportions and architecturally and decoratively impressive. The list of papers read has already been published in Engineering News, along with some of the advance papers courteously placed at your disposal by the Secretary of the Institute.

The two sessions for the reading of papers consumed not more than five hours; for as the papers had been previously printed and distributed among the members, the salient points and conclusions alone were read by their authors. The discussions were also brief, as a rule, and some papers were not discussed at all. The President-elect was certainly an adept in facilitating the despatch of business, neglecting no detail, and losing no time. The remaining time was expended in excursions, receptions, luncheons and teas of a delightful character. The railway arrangements were excellent and liberal in scale; and overflowing hospitality marked the reception of the members at the Oldham Works of the Platt Bros., at Chatsworth by the Duke of Devonshire, at Salford, by the mayor of the city, and on the Manchester Ship Canal by the company.

My personal interest was in the last-named excursion, which, in two steamboats, left on Aug. 16 for a short trip on that pet of Manchester, the Ship Canal. Those who had never actually appreciated the smell of raw, black sewage, were afforded an opportunity to extend their acquaintance in that direction most thoroughly on that interesting voyage. The sewage of Manchester and Salford is turned directly into the Irwell River, which supplies the canal with water until it is met by the waters of the Mersey; the canal itself is but a vast open sewer, and such it must remain until Manchester is rich enough to purify its sewage before sending it to the canal. The water now is black and "shiny," and the gas bubbles keep it constantly effervescent. When the screws of the steamer churn up the odoriferous mass the water shows a sienna color. At the Barton Locks, several miles down the canal, the gas bubbles were not so much in evidence, but the water was quite as deeply colored as at the Manchester terminus, and quite as fragrant. But, allowing for this little disagreeable feature of the great canal, which to the average seaman is not of much account, and against which the citizens of Manchester will not rail very loudly if only there is sufficient commerce to stir the dark waters up to a point of actual profit on the vast investment, it is an exhibition of most wonderful faith in the future of Manchester, which in due time is certain to be rewarded.

Already the banks and vicinity for several miles are covered with factories, lumber yards and warehouses; docks for shipbuilding and repairs are in operation; the facilities for loading and unloading vessels are of the most modern and convenient type; every encouragement for capital to locate along the canal is given, and it is not a rash prophecy to say that a quarter century hence—a small term in the life of a city—that the far-sighted men who projected and built this great commercial highway to their city will see the fulfilment of their most sanguine hopes. By the free movement of the big iron steamers, which were in frequent evidence, it seems as if the dangers of "locking through" such moving masses had been practically overcome; they were not referred to and probably are not serious. Two small excursion steamboats ply for a few miles to and fro on the canal, and as the color and smell of its water are those associated with that fluid in the minds of the average Manchester citizen who goes on such excursions, the serenity of the excursionists is not at all disturbed.

There are ways and means of inducing and creating a traffic for the ship canal with which the uninterested casual observer is not acquainted, but in conversation with directors of the canal and with other Manchester men, one soon learned of the far reaching designs and the unremitting industry which, in time, are expected to work out a successful issue. Among the sources of revenue for this canal the world at large does not hear of the network of feeder canals which convey the products of the midland counties to Manchester as a distributing point. But in traveling from Birmingham to Manchester by the London & Northwestern Ry. I was surprised to see the labyrinth of canals penetrating the manufacturing districts of Birmingham, and as far as Wolverhampton, and on which long but very narrow boats were being rapidly propelled by horses. There was none of the leisurely pace of the usual canal boat, but the impression one gained was that time was an essential element of the contract in this vicinity. Wherever the railway sidings are expected to go, usually there was a branch canal—it was a veritable Dutch condition of commerce. The same conditions prevail at Manchester, and the following are "feeders" and distributors for the Ship Canal, besides the railway lines operated by the Ship Canal and other companies: Aire and Calder, Ashton, Bridgewater, Bury and Bolton, Calder and Hebble, Huddersfield, Leeds and Liverpool, Macclesfield, Peak Forest, Rockdale, Shropshire Union, Stockport, Trent and Mersey, Weaver and Navigation. The direct revenue of the canal is already providing for the interest charges on some of the debentures, and the indirect benefits to the city are not easily estimated.

I joined the excursion on Aug. 18 for Chatsworth and Haddon Hall and returned to Birmingham the same evening.

On Aug. 24, provided with an official "permit," I drove over to the Birmingham Sewage Farm. The dry weather daily flow is about 22,000,000 gallons of sewage; it is treated, on its entrance to the farm, with lime only—18 tons per day—and, passing on about a quarter of a mile, arrives at the settling tanks; there are three of these large tanks, subdivided into three each by dividing walls; the heavy material, composed of road detritus, lime and other weighty substances, is deposited in the first 50 ft. of the first compartment; the liquid sludge is deposited in the succeeding compartments; the effluent, in a rather cloudy condition, flows onward to another series of tanks, each of which is constructed to hold one-sixteenth portion of the daily flow reaching it; the further purified sewage passes from these tanks in an aerating cascade and thence to the valve house, some two miles farther on, where through four outlet pipes on varying levels it is distributed over the cultivated areas.

Returning to the three first settling tanks: One tank is emptied each week, thus allowing for 14 days accumulation in each. A steam crane was at work lowering and raising a large dredging bucket which lifted the heavy mud out of the tank into dump cars at the surface; the arm of the dredge reached only about 25 ft. from the end of the tank and so the balance of the mud had to be wheeled in barrows within reach. There was scarcely any odor from this accumulation of mud, and it was taken away in cars to dump in low ground. The sludge was lifted by a continuous bucket dredging apparatus into lines of square wooden troughs supported on posts at a height of about 20 ft. above the top of the tanks, and running in long lines over the farm at a descending grade of 3 ins. per 66 ft. These troughs were made of one plank on each side 11 ins. high, and for the bottom 2 planks 9 ins. each, bolted with 1½-in. rods; the bottom was not tongued and grooved, but any possible leakage was soon stopped by the caiking of the sludge itself. There is about one mile in length of these troughs and they are taken down and removed whenever and wherever necessary.

Into this trough and its debouchements, then, the semi-fluid sludge is elevated from the first tank, the bottoms of the other compartments sloping toward this first tank; men who are called "bootmen" travel along in the trough, each man a measured distance, and push forward the viscous filth until it flows out onto the roughly terraced slope to which it has been directed, and slowly fills up the beds thus improvised. It is then sprinkled with soot to lay the odor, and commencing at the bottom of the slope it is dug into the ground, about 57 acres annually. There were only ten men engaged in this delectable industry at the time of my visit, but the superintendent said that the regular gang was 30 men, which included the men handling the stuff in the settling tanks, working the steam elevators and dump wagons and pushing the sludge in the troughs. These men are all on "piece work" at the rate of 3s. 3d (= 80 cts.) per 64 yds. square of land dug; the "bootmen" in the aerial troughs get one-half penny per cubic yard measured in the tank, and the sludge must be pushed 700 yds. lineal; for any excess of distance over that 3s. (= 75 cts.) per 100 yds. is paid. The city pays for boots and flannel coats worn by the men, as they must work rain or shine. The superintendent said that they could average 5s. (= $1.25) per day, and some of the men had been at this kind of work for more than 20 years, and ill health was quite unknown.

The farm is a little less than 2,500 acres in extent, and stretches along a valley for about four miles; at the Birmingham entrance are the liming and precipitation works; at the other extremity are the residence of the engineer and the stables and granaries. Two hundred cows are kept in the stables; their milk is sold to a contractor; 250 heifers and bullocks are fed for market; five crops of grass are cut annually; all feed is ground in the buildings; hay is stored and pressed; a vast quantity of vegetables is sold for city consumption; at the "digging in" lots I noticed the acres of rhubarb of immense size of stalk; 336 men, 97 horses, 2 traction engines for ploughing, and one for street rolling, pumping, etc., are employed on the whole farm.

The land near the farm buildings was simply broken up most roughly and left so; large pools of sewage were "ponded" over the place; drains are 4 ins. to 12 ins. diameter and about 5 ft. 6 ins. below the surface; the land is gravelly. The effluent at the farm buildings was about as clear as ordinary raw domestic sewage; the liming apparatus is old and not doing full duty. I first discovered the location of the farm by the smell about half a mile away; the odor, however, was not really offensive, except at a place about one-quarter of a mile wide, and there it did announce its presence in the loudest sort of way.

This is the largest sewage disposal farm I ever visited; the Croydon farm had mostly domestic sewage to treat; in Birmingham the washes of manufacturing establishments are vast and various, and the city is a populous one; it is a big problem to care for the disposal of 22,000,000 gallons of such sewage daily, and I do not yet feel that I am qualified to criticise the men who are presumably competent to superintend such a great work. G. H. F.

London, Aug. 28, 1899.

The Southampton Congress of the Sanitary Institute.

Sir: Southampton, the ancient and mildly ambitious seaport of the South Coast of England, is swarming with sanitarians this week, and probably 2,000 is not far from the number actually attending the congress. The eight sections under which business is conducted are divided in representation as follows: Municipal Representatives, Port Sanitary Authorities, Medical Officers of Health, Medical Officers of Schools, Engineers and Surveyors to County and other Sanitary Authorities, Veterinary Inspectors, Sanitary Inspectors, and Ladies. On Wednesday all of these sections met to listen to presidential addresses and papers and on Thursday and Friday there were meetings of Sections I., II. and III., dealing with "Sanitary Science and Preventive Medicine," "Engineering and Architecture" and "Physics, Chemistry and Biology," respectively.

Nearly all of the addresses and papers had been previously printed and distributed, and copies have been forwarded to Engineering News. The classrooms of Hartley College and rooms in other buildings were utilized for the many meetings, and there was the usual official reception by the Lord Mayor. The event of Tuesday was the presidential address of Sir William H. Preece, the celebrated electrician and President of the Institution of Civil Engineers; and the honors of the congress were undoubtedly shared between this clear-headed scientist and Prof. Percy Frankland, President of Section III. There was a large attendance of civil engineers, including under this head District, Borough and Town Engineers and Surveyors, and it was naturally to the meetings of their sections that I gave my attention. So many people were determined to hear the address of Prof. Frankland that for a few minutes it looked as if the meeting of the section would be completely demoralized. But, after a full hour's delay, the large lecture hall was secured by exchange with Section I., and an exhibition of discourtesy to the professor was cleverly warded off by the patience and firmness of Sir William Preece, acting as chairman of the meeting.

Professor Frankland is a man apparently in the middle thirties, tall and well proportioned, with a well bronzed face, which also is most noticeable for its expression of self-reliance and determination of purpose. His natural gravity of countenance was probably intensified by the

recent death of his distinguished father, to which, in introducing him to his audience, Chairman Sir William Preece referred very briefly. Prof. Frankland read from his manuscript very rapidly, but also very distinctly, so that everybody in the large hall could hear him easily. He stated in his opening remarks that sanitary science did not receive the support of the higher classes of English society; the men who govern the country were more interested in spending large sums of money on military and naval enterprises than in promoting the better conditions of life at home. Three British Blue Books of recent date had, however, dealt with subjects of great importance to the working classes; they referred to accidents from water gas, lead poisoning in pottery works, and the dangers of the sulphur matches industry. Passing on to the subject of bacteriology the professor remarked that the day had passed when the biologist and the bacteriologist and their studies were treated with ill-concealed contempt by the scientific world. But the results of the study of bacteriology have not fulfilled the expectations of enthusiasts. The bacterial purification of sewage is not a new discovery; the conditions have been recognized by investigators through many years, and bacteriological study is pointing the way to success. In well-organized shops men and machinery were classified into departments for the most effective working; even so the bacteria were being given separate workshops; the Anerobic without air or light to do their work in, the Aerobic theirs with plenty of air and light; hence arose the necessity for the new devices which are now being brought to the attention of municipal bodies for the treatment of sewage.

Unstinted applause followed the reading of the paper, after which Sir William Preece, in moving the usual vote of thanks, called attention especially to the bold and manly arraignment by Prof. Frankland of the higher classes of society for lack of sympathy with the progress of sanitary reform; he acknowledged the difficulty of reaching this class through such meetings as the present congress, and, as it must be through public opinion at last that such reforms are to be accomplished, so they must first instruct themselves; they must secure enthusiasm in the profession so that in turn that enthusiasm may be imparted to others. But, above all the assistance of that powerful engine of public opinion, the press, must be secured. And the press must be supported; it was "not in business for its health only," but for revenue; he had noticed in the Southampton papers that morning that a page was devoted to sporting intelligence and about two inches of one column to the proceedings of this important congress; he hoped that such a paper as that of Prof. Frankland's might stimulate the press to do more for them than they had heretofore.

The chairman's arraignment of the Southampton daily press was well deserved. A city of 100,000 population, it has only one wretched daily newspaper, issued in the evening, so that the London papers are the only morning dailies. A reporter, sitting beside me, explained that an attempt was made to establish a morning daily but after three months of a losing game it was abandoned. There were several reporters in attendance at the congress, but it was impracticable to attempt reporting at any length the discussions of these strictly technical meetings; much of what was rapidly "spouted out" from all over the rooms was quite unintelligible to the ordinary news reporter, and frequently inaudible from noises inside and adjacent to the place of meeting. It can hardly be realized, however, in the United States, where every town of a few thousand inhabitants has its one or two daily papers, how dependent all England is upon London for its morning news of the world. Only cities like Birmingham, Manchester, Liverpool and Glasgow can boast of first-class daily newspapers. But this is digressing.

Southampton provided the visitors with a good programme of excursions, luncheons, teas, receptions, etc., varying in flavor from a smelling excursion to the sewage farm and precipitation works to a visit to Osborne House, which the Queen, after much pleading by influential parties, graciously allowed for Saturday, the day after her own departure for Balmoral, and the number of visitors to be limited to 400. On each and all of the excursions the number admitted was necessarily limited, as the transportation of a mob of 2,000 men and women is not easily provided for at short notice. Your correspondent was so thoroughly satisfied with his seven-mile tramp through a Manchester factory, his voyage on the sweet-smelling ship canal, and the day's alternate driving and walking twice to Chatsworth, supplemented with four square miles of Birmingham sewage farm on a blistering hot day, that he only applied for a chance to get a comparative smell of the Southampton farm and failed because there were too many ahead of him. However, the farm was open at any time to visitors who cared to go there.

The meeting of next year will be held in Nottingham. It is not easy to secure rooms for meetings, and hotel accommodations for so many people, and only large cities are available. It is, however, an encouraging feature of English life to-day, when so many men and women, moved by pure enthusiasm for better conditions of living, will devote days and weeks of intellectual labor, and also suffer much real inconvenience, to prepare for the coming of this ever-growing congress, where they may discuss the best ways and means of bettering their fellow men. It is to be hoped that their enthusiasm may be contagious and that their most sanguine hopes may yet be realized.

Southampton, Sept. 1, 1899. G. H. F.

MODERN METHODS OF SEWAGE DISPOSAL.*

By Sir William Henry Preece, President Inst. C. E.

The system of treating and disposing of sewage can be considered under three heads: (1) Mechanical. (2) Chemical. (3) Biological.

The first system deals with the removal of all the organic and inorganic matter in sewage. The former is putrefactive and may become offensive. The latter is matter in the wrong place, and must be collected. Both forms must be removed. The mechanical system includes the committal of the crude sewage to earth improved in the present day by the dry earth system, the distribution of the contents of the cesspools over and in the land, and the simple water-carriage system to the sea or to the river.

The second system includes various plans for the precipitation of solids, the filtration of liquids, and the formation of artificial manures.

The third system extends the second to the aeration of the clarified sewage, so as to secure the nitrification of the organic matters in suspension or solution by bacterial agencies, to enrich the land, and to purify the effluent for further use.

I. One of the best examples of water-carriage discharging into the sea is at Portsmouth, where Sir Frederick Bramwell, taking advantage of the direction and velocity of the tidal currents of the Solent, has disposed of the crude sewage so as to avoid any possible nuisance or interference with the enjoyment of those who frequent Southsea beach. Bazalgette did the same at Torquay, while Brighton and Margate are excellent examples of similar good sea disposal. It is not, however, economy or wisdom to make too much use of the sea. It is not so good a natural purifier as a river, for it is deficient in the proper bacteria, and the stuff discharged therein is wasted. Nor is it wise to ignore the sea; for in the Rhonda Valley, although the upper part of it is 27 miles from the sea, it has been found more economical to construct an intercepting sewer for the whole valley, discharging in deep water in the Bristol Channel.

II. Chemical treatment is well illustrated in the case of London, where it has hitherto been in operation without any supplementary process, but where recently some very important experiments have been conducted to determine the conditions that would justify the introduction of the biological system. The crude sewage is admitted into precipitating tanks, where it is treated with lime and sulphate of iron in definite quantities. These cause the chemical transformation of the elements and compounds in solution to form solids, which with those already in suspension slowly settle by gravitation as sludge. The effluent flows into the river at Barking and Crossness. Over 2,000,000 tons of this wet sludge are conveyed every year, 50 miles to Barrow Deep, where they are deposited in the sea. The improvement of the Thames in consequence has been very marked. Fish have reappeared; seagulls appear annually above London Bridge.

Mr. George Chatterton is carrying out works for Dublin similar to those in London, but the sludge will have to be carried away only 10 miles into the Irish Channel. It now goes direct into the River Liffey, which flows virtually as an open sewer through the city, causing an almost intolerable nuisance.

Where the sea is not conveniently placed for the reception of the sludge, land is irrigated, or sewage farms established. Wimbledon, where I reside, is one of the best examples. It has recently added biological filtration to the process. The solid matter suspended in the crude sewage is retained mechanically in a porous screen made of broken bricks. It is then passed into the precipitation tanks like those of London, and after settling, the sludge is run into a reservoir. It is then mixed with lime and compressed into cakes. 100 tons are so formed weekly. There is no market or demand for this cake, so it is going to be burnt in a destructor connected with the electric light installation.

The effluent is run twice on to the sewage farm where 60 acres are cultivated at a profit, with rye grass, osier, mangel wurzel and other market gardening; it then passes purified into the river Wandle. The population is growing so rapidly that the land has become too small, and the biological treatment will have to be considerably enlarged. Land treatment, either by itself, or after the solids have been removed, forms, by the requirements of the Local Government Board, an essential feature of every scheme for the disposal of the sewage of an inland town in Great Britain. Unfortunately sewage farms as a rule do not pay. It will be a great relief to get rid of them. We have seen during the past session of Parliament how the camp sewage farm at Aldershot has been violently attacked. The new biological treatment may modify the views of this board. It is a department extremely well advised and ably administered, and we may be sure that if the experimental success of the new system be followed by a sound, practical result, it will carefully safeguard the public requirement and health.

Brewery refuse is difficult to treat. It contains much organic matter, degenerate yeast and water containing sulphates. It has been a source of much difficulty when admitted into public sewers. It should, indeed, be treated at the brewery.

III. The new biological treatment is a return to Nature. "Nature never yet betrayed the heart that loved her." That wonderful micro-organism that has eluded man's observation for all these millions of years is divided into two classes—(a) bacteria which work with oxygen, and (b) those which do not. The sewage first reaches the settling tanks, where the inorganic matter, such as sand and grit, is deposited. The albuminous and organic matters and urea which are found in all sewage are then transformed by bacteria into forms of ammonia. The decomposition of animal and vegetable matter, which is invariably due to the action of these bacteria, is thus utilized to liquefy organic solids and in this way to simplify their removal. Other bacteria gradually, in special filters, transform the ammonia by the aid of oxygen and other elements present into nitrates. The process of filtering is intermittent, for air is essential to maintain the supply of oxygen to the nitrifying bacteria; but an air blast, in some cases, is used to maintain a continuous action. The nitrifying effect is enhanced if the air be warmed to about 100° F. The filters must have porosity and resistance to flow to retard the passage of the sewage through them, for time is essential for the bacteria to grow and to act. In sandy ground Nature does this, but on clay formation, coke-breeze, and even coal, is found to be very effective. In this way bacteria first liquefy the solid matters in the sewage, and then nitrify them, simultaneously purifying and enriching the effluent, and preventing the formation of that wasteful product, sludge. Bacteria thus fulfil the highest function of the engineer, and Nature asserts her power in fulfilling the clearly-defined will of the Great Creator. The biological system has clearly come to stay. It is, however, still in the experimental stage. No great town has committed itself to its general use. The patent list shows that finality is not yet reached.

Biological methods may be divided into two classes: (a) Those which deal with sewage, clarified by precipitation and filtering; and (b) those which attenmpt to deal with crude sewage. The former plan appears so far to be the most effective. It has been recently applied by Mr. Chatterton to Merton, where unsuccessful have been converted into successful works. The second plan has the merit of greater simplicity; and if the action of the different bacteria be simultaneous, and not successive, it may possess the method of practicability, as well as of economy. More experience is really needed. A Royal Commission is now sitting considering the whole question. It may be some time before their report is ready. The chairman has issued a circular to local authorities, foreshadowing a long inquiry, and deprecating any delay in carrying out schemes on the ground that the promoters are waiting for the report of the commission.

The London County Council are making very valuable and extensive experiments at Crossness, and the conclusion of their result will have a very far-reaching influence in the country generally on this great hygienic question. An equally important experiment is being made in Exeter, where the septic tank promises great assistance to those who have so much interest in the treatment of the sewage of small places, villages, hamlets, and isolated dwellings. The water supply of Carnarvon, where I have a summer residence, is drawn from a lake called Quellyn, into which the drainage of the village of Rhydd-du indiscriminately enters without any treatment whatever. The typhoid or diphtheretic bacillus thus might find its way to Carnarvon. No pollution of a river by unpurified sewage, however minute, should ever be tolerated; particularly when it occurs above the intakes of the water supply of a populous district like Carnarvon. This has alarmed the Town Council of Carnarvon, who have very properly agreed to share the expense of treating the sewage. The septic tank process could economically and effectively be applied at such a place.

Darwin was perhaps one of the first to point out how the lower animal life assisted Nature by absorbing as food the decay of vegetation, digesting it and excreting it in the form of mold and loam. His observations on the growth and functions of worms is not the least philosophical and scientific portion of his great labors. He probably attributed to worms much that is done by bacteria. Pasteur, the father of the germ theory, taught us how bacteria acted as Nature's chemist by showing how the yeast germ produced fermentation, and the commercial conversion of alcohol into vinegar shows how another micro-organism takes up oxygen from the air and unites with the hydrogen of the alcohol to form acetic acid and water. The actual mechanical processes through which bacteriolysis pass, expending energy, transforming matter and promoting life, form one of the most interesting pages of the history of evolution ever narrated for every stage of its growth, has occurred during the present generation and within the experience of most of us. Koch, in Ger-

*Extract from the Presidential Address before the Sanitary Institute of Great Britain, at its Southampton meeting, Aug. 30, 1899.

many, has been a worthy disciple of Pasteur. The intermittent benefit of filtration was discovered in the laboratory by Frankland in 1870. Warrington found in 1882 that sterilizing by boiling and antiseptic treatment stopped all nitrification. Aerating filters and the true action of bacteria were developed at Lawrence, in Massachussets, from 1889 to 1893, Scott-Moncrieff introduced in his group of trickling cultivation beds in 1891, Dibdin commenced his experiments in Barking and Sutton with filter beds shortly after, Cameron introduced his septic tank in Exeter in 1895, Ducat his continuous filtration process in 1897, and now step by step in Germany, France and England we have reached a point where we can fairly say that sewage can be effectively treated with safety, simplicity and economy by natural means.

Electricity has not played an important part in assisting the sanitary engineer in his attack on sewage. Attempts have been made to assist the oxygenation of water by electrolysis, and the Hermite process has been introduced in Ipswich and in Netley Hospitals. The Hermite process decomposes sea water into a powerful antiseptic, disinfectant and deodorizer. The liquor produced, containing chlorine and chlorites, is called hermitine, and it is laid on at Netley like water. Its economy is doubtful, in face of the astonishing effects produced by the natural process of bacteriolysis.

WATER WASTE BY AUTOMATIC SEWER-FLUSHING TANKS.

At the Cincinnati meeting of the Central States Water-Works Association, Mr. George Hornung, M. Am. Soc. M. E., and Superintendent of the Newport, Ky., water-works, called attention to the unnecessary and extravagant waste of water that may follow the improper use of automatic flush-tanks for sewers. We abstract his paper as follows:

This waste may result from two causes; first, lack of knowledge of the principle of the use of flush-tanks on the part of the person in charge, or, second, indifference to the interests of the city, even when the working of the system is understood. Mr. Hornung believed that if the operation of the tanks were not in charge of the water department, that department should closely watch the methods pursued, the tightness of the tanks and their general condition, and stop the waste of water. The difficulties in the way of so doing, would be the friction likely to result from one department interfering with the business of another, under our present municipal organization. But by firmly standing out for his rights as the custodian of the water supply, the Superintendent of the Water Department can do much in the way of stopping abuses.

In the case of Newport, Ky., the sewerage system was put in operation in 1894-5, with 65 flush-tanks connected, having a capacity of 250 gallons each. Water is furnished free by the Water Department to all the city buildings, the park and school houses, and for flushing sewers and street gutters and for cleaning streets, etc. Mr. Hornung was made Superintendent of the water-works in 1897, and was charged with the duty of stopping leaks and waste of water by virtue of his office. He early turned his attention to the flush-tanks and his inspector reported as follows:

Every tank was turned "full on," and the tight tanks, of which there were only 13, were dumped every 30 minutes; some of the leaky ones were not dumped at all, and the rest dumped at intervals of from one to six hours. Mr. Hornung ordered his inspector to shut off all leaky tanks, and to regulate the tight ones so that they should dump twice in 24 hours. This order brought about a sharp controversy with the official in charge of sewers, who resented interference with his duties, as he recognized them. But by interviewing this official and laying before him the views of acknowledged experts on this subject, regulations were finally adopted that checked the abuse. These regulations chiefly related to the care and tightness of the tanks, and the proper amount of water to be nsed in flushing.

Mr. Hornung estimated that under the old lack of system the waste of water amounted to 748,500 gallons per day for the 65 flush-tanks. In 24 hours these tanks had used 780,000 gallons when their proper use would have required only 32,500 gallons. The actual daily loss to the Water Department, in fuel, engine supplies, extra labor and repairs, was $6.75 per day, or $2,463.75 for the year. If the water wasted had been paid for at 10 cts. per 1,000 gallons—the current charge to city consumers, the daily receipts of the Water Department would have been increased $74.85.

AN OWNER IS WANTED FOR RAILWAY TIES piled up on the bank of the Amazon River at Para, Brazil, says U. S. Consul Kennedy, of that city. They are said to belong to an American syndicate that undertook, about 1881, to build a railway around the falls in the Madeira River, but failed for lack of funds. The Collins Bros., of Philadelphia, were the contractors. Mr. Watrin, of Watrin & Co., of Para, wants to buy the ties if the owners can be found.

A LARGE GAS HOLDER has just been completed by the Corporation of Birmingham, England, which is claimed to be exceeded in size by only one other gas holder in the world. The new holder is 264 ft. in diameter and 160 ft. high when extended to its full height, and its storage capacity is 8,250,000 cu. ft. Apart from its great size this new holder does not differ in any essential particular from the usual construction of such structures.

THE POUND WEIGHT IN GERMANY, says U. S. Consul Brodowski, is still in every-day use, notwithstanding the fact that the metric system is the legal standard; and as smaller German firms may order goods from America in pounds, trouble is likely to arise if the order is filled in American pounds. The old German pound, and the one still used by many, is exactly one-half a kilogram, or 1.1023 American pounds.

THE AMERICAN PAPER INDUSTRY has been recently reported upon by the Department of Labor, for the first six months of 1898. This report shows that 723 plants were in operation in the United States, and the actual product for the half year named was 904,087 tons of paper and 619,383 tons of pulp, valued at the mill at $48,689,880 and $13,428,542, respectively. Much of this pulp, however, entered into the manufacture of the paper produced and it is impossible to state the total value of the output. Nearly one-third of the paper made was newspaper, in rolls and sheets; or, 311,898 tons. For books the output was 124,339 tons; wrapping paper, 72,093 tons; strawboard, 70,694 tons; and Manila wrapping, 66,383 tons. Of the 619,383 tons of wood pulp paper, 367,744 tons were ground-wood pulp; 173,420 tons were sulphite fiber; 74,379 tons were soda fiber, and 3,840 tons were cotton fiber. The paper production for the year 1890 was valued at $74,773,093, and the value of pulp made was $5,152,039.

BOOK REVIEWS.

LOOKING AHEAD: Twentieth Century Happenings.—By H. Pereira Mendes. Author of "England and America," "The Solution of War," etc. New York: F. Tennyson Neely. 8vo.; cloth; pp. 381.

Those who try to foresee the far future by the light of the present have a difficult task. Very few of the many books of this sort which have been written have presented a picture of the future which has proved in large degree true or which has even commended itself to men generally as according to reasonable probabilities. Dr. Mendes' book is no exception to this rule. Indeed, the author has intended rather to give free rein to fancy than to present a really prophetic picture of the future. Certainly if the first half of the 20th century is to see even a tithe of the frightful things which Dr. Mendes foresees, most of us will be thankful that some part of our lives was passed in the 19th. The author's arraignment of the evils of the present day is perhaps the best part of the book. Here he shows himself a clear observer and for the most part a sound thinker.

MODERN PLUMBING, STEAM AND HOT WATER HEATING.—A New, Practical Work for the Plumber, the Heating Engineer, the Architect and the Builder. By James J. Lawler, Author of "American Sanitary Plumbing," "Hot Water Heating," etc. Boston: Desmond & Co. New York: The Chiswick Publishing Co. Cloth; 7×10 ins.; pp. 397; 284 illustrations, including a few folding plates. $5.

This seems to be just what the sub-title says it is, a practical work for the plumber and his colleagues; in fact, for anyone who wishes to find the principles of plumbing and heating set forth in clear, plain language, supplemented by an ample number of sketches and other illustrations, many of which tell the story without the aid of the text. If every plumber, architect and builder in the country had the principles laid down in this volume well in mind, and lived up to them, there would be a great saving of life, health and money. Plumbing and health inspectors should know some such book as this by heart, and it might well find a place on the library shelves of physicians who practice in cities and villages. The author does not hesitate to recommend special makes of plumbing fixtures. We have not attempted to decide whether any undue favoritism is shown in this particular, but in some cases we think it more than likely that others equally good are not mentioned.

HALL'S TABLES OF SQUARES.—Containing a True Square of Every Foot and Fraction Thereof from 0 to 100 Feet. By John L. Hall. New York: Engineering News Publishing Co. Leather; 3½ × 5¾ ins.; pp. 200; $2.

The value of tables of squares in facilitating calculations, providing these tables are sufficiently comprehensive and accurate, hardly needs explanation to engineers. The book before us aims to include both these necessary qualities of comprehensiveness and accuracy and in our opinion it more nearly succeeds than any other book of squares with which we are acquainted. Briefly stated, the tables have been prepared with the definite object of correcting the errors due to the employment of inexact roots in their calculation which are found in other similar tables, and they comprise the square of every foot and fraction thereof down to sixteenths of an inch from 0 to 100 ft., which is twice as high as any other tables of squares run. Consultation is facilitated by making the page numbers agree with the number of feet to be squared; thus, to find the square of, say, 39 ft. and any fraction over up to 40 ft., the reader has simply to turn to page 39. All the squares pertaining to any foot are thus before the reader at one time. A separate column of the tables is devoted to each inch, each column being broken by blank spaces into quarters, and each sixteenth of an inch having a separate line. To enable them to be easily distinguished, the roots are set in heavy face type and the squares in light face type. The book is of convenient pocket size with flexible leather covers, rounded corners, and guilt edges, and is printed from entirely new type. An introduction explains the calculation of the tables and gives directions for their use and for calculating from them squares exceeding 100 ft.

COMPOUND ENGINES.—By James Tribe, M. Am. Soc. M. E.; first edition, Racine, Wis.; pub. by author. 4½ × 6¼ ins.; pp. 137; illustrated; 17 tables. $1.50.

This book is a reprint of a series of articles which have appeared in the "American Machinist" at various times under the same title. It belongs to that class of books, addressed to the "practical man," which attempt to make difficult subjects easily comprehensible by the use of arithmetical illustrations. In this the author has succeeded, in that he has made it possible for anyone by closely following his rules to determine the main points arising in the design of compound engines, but it is to be feared that the reader without other preparation will gain very little useful knowledge of the principles involved. It seems to us that more space might have been profitably devoted to the proper care and management of this class of engines, treating such subjects as the setting of valves, the interpretation of indicator cards and the many other things that it is useful for a man in the engine room to know. As for the engine designer, he has at his command and is able to use a great many treatises both more thorough and more complete than the one under consideration. The illustrations, which are reproductions from photographs, are good, but they should be supplemented by line drawings showing more clearly the working parts of the machines. The book contains many useful rules and tables, and ends with a chapter of definitions, some of which are novel and original, but hardly useful. We quote the following examples:

Boiler Efficiency.—That measured by the heat absorbed by one pound of combustible, when divided by heating value of one pound of combustible.

Convertible Energy.—The work performed by equalizing the temperatures and pressures within a given space, to or from which there can be no conduction of heat and whose volume cannot change. The author adds that this is called by some the "Eutrophy of the System."

Later he tells us that "one cubic inch of water evaporated under 14.7 pounds pressure may be converted into 16.42 cu. ins. (about one cu. ft.) of steam at the same pressure, and will exert a mechanical force equal to raising $14.7 \times 144 = 2{,}120$ lbs. one foot high." Power is defined as "Force multiplied by distance, multiplied by time."

PAPERS AND REPORTS AT THE ANNUAL MEETING OF THE ROADMASTERS' ASSOCIATION OF AMERICA.

Standard Right of Way Fences.

Railways should adopt a standard fence. The old wooden board panel fences rapidly decay and readily burn; they require too many posts, and are too expensive, except where some special design is desired for specific reasons. The same objections hold good against combinations of wood and wire. The hedge has not proven a successful substitute for a fence, for the reason of the expense in securing a good growth, the labor required in keeping it trimmed, and the danger of destruction by fire. It is a great objection to adjoining land owners on account of the shadows cast, which makes the land adjoining practically worthless, unless the hedge is trimmed twice a year, and it frequently obscures the view to approaches of highway crossings.

Barbed wire has only one argument in its favor—cheapness. This may commend it where the law and landowners will consent, but it is rapidly being outlawed. It never was an effective fence, as it was impossible to build it so it would turn small animals, such as pigs, lambs, etc., and has proven itself to be anything bit a humane and efficient enclosure.

The smooth wire is the logical successor of all other

fences. It will not obstruct the view or mar the landscape; it will not cast a shadow over growing crops, and will permit cultivation right up to the fence. There are two kinds: hand woven in the field and woven complete in factory. For railway purposes the factory woven would prove the most economical and most reliable article, as no hand-made fabric can compare, for uniformity of tension and completeness of finish, with the power woven competitor.

The elasticity of wire is demanded by change of climate, climbing of trespassers on right of way, the contact of stampeding animals, by overflowing of streams, and drifting snow, or by any severe strain which will carry the taut wire out of the straining line or demand of it greater length than was reserved at the time of straining. It must be provided, or either the ends will draw or the wire stretch and weaken or perhaps break. In either case it will not again resume its former position. To be most effective, elasticity must be evenly distributed, for the reason that no one can tell where the attack will be or how far either way it will be felt.

Cabled wires will not provide sufficient elasticity and are deceiving as to tensile strength. Actual test shows the gross strength not equal to that of individual wires; probably because uniform length cannot be secured. They have proven a failure for horizontals or verticals in wire fence, from the fact that their shape renders them ready collectors of soot, moisture and substances destructive to metals, such as are produced by the gases from coal used in locomotives and by manufacturing plants adjacent to tracks.

Coiling or crimping—not kinked—in any kind or size of wire are of little account for elasticity, unless the wire is hard and springy,and if it is of this quality all short bends cannot fail to injure the fiber of the wire, and weaken it perceptibly. To be serviceable the coil must be made so that the grain or fiber of the wire is not twisted in the process of either coiling or uncoiling.

Soft wire in a woven fabric, if put to severe strain, will stretch, but never contract again, thus ruining both appearance and usefulness. Provision for expansion and contraction in a soft wire fence is useless, while a high carbon wire without such provision would be even less serviceable than its cheaper, soft neighbor. Hence, it is folly to claim to use, in common straight wire fences, the same quality of wire as is absolutely necessary in a first-class coiled wire fence.

The cross-ties are mainly spacers preventing the horizontal wires from being forced apart and they add no particular tensile strength to the fence. If heavy wires are used for cross-ties on elastic fence they will become bent and crushed down by accident or otherwise, and if once sharply bent, will, of course, hold the fence out of shape and render it unfit for service to that extent, while under the same circumstances a cross-tie of small wire would be promptly drawn back to place by the contracting force of the horizontal wire.

Horizontal wires are recommended to be, top and bottom, No. 7 American gage, and nine intermediate wires, No. 11. All wires should be thorpughly galvanized, particular attention being given to having the coating smoothly and evenly distributed.

A wire fence of good height will stand up better and longer and there is much less danger of stock jumping or being injured, or of stock being thrown over it in a stampede or accident. Your committee would recommend a 5-ft. fence with horizontal wires, spaced as follows, from top: 8, 8, 8, 7, 7, 6, 5, 4, 3, 3, ins. apart, there being 11 horizontal wires with cross-stays placed 12 ins apart.

It is doubtful if any metal post yet devised is to be recommended over wood. The tendency to corrode and the exceeding weight and cost, if sufficient metal is used to guard against rust and corrosion, is a serious objection. White and red cedar, locust and oak, are doubtless the best generally obtainable. With an elastic fence, posts should not be placed so close together as to seriously reduce the ability to expand in case of shock. For the same reason, staples should not be driven so closely as to prevent the wire drawing when necessary, on line posts.

For right of way fences, the distance of 16½ ft. to 20 ft. between posts, seems to be the choice of experience, though many use longer distances.

The successful right of way fence must be so constructed at to be able to stretch over any ordinary surface of ground and without cutting and buckling. This is another point in favor of not too heavy a cross or vertical wire. Many small items enter into cost of erection. A smooth fence in compact roll, which will unroll without catching, or in which the horizontal wires are of uniform length, requires only common labor and a complete set of tools suitable for its construction at a minimum cost.

J. A. Prentice, John Wirley, John Ennis, Walter E. Emery, Committee.

Increasing the Length of Rails, Using Miter Joints, and Determining the Difference in Expansion of Light and Heavy Rails.

We find that about eight railways in the United States have purchased, and are using 45 and 60-ft. rails. The use of rails over 30 ft. in length was commenced experimentally about nine years ago, and while results in some instances have proven quite satisfactory, it may be said that not enough time has yet elapsed to fully develop either the advantages or disadvantages. The advantages claimed for the 60-ft. rails are the reduction of 50% in the number of joints, and a better riding track, maintained with less labor. The objections to 60-ft. rails are as follows:

(1) That they are not properly straightened at the rolling mills. While this would seem to be a question of mechanical skill, yet the complaint is general, and indicates that the mills are not prepared and are unable to straighten 45 or 60-ft. rails, as well as the 30-ft. rails. (2) Complaints are made by trackmen that more labor is required on 60-ft. rails, in order to secure good surface, than on the same length of track laid with the 30-ft. rails; this on account of the rails springing and not coming to a uniform surface. (3) The increased opening required to allow for expansion.

It is claimed by many trackmen that not more than 50% more expansion is required for 60-ft. rails than for 30-ft. rails; but as few roads have used less than 50% with satisfactory results, and not having been able to establish the fact scientifically, your committee cannot vouch for its truth.

Inquiries at the leading rolling mills in this country reveal the significant fact that rails 45 and 60-ft. in length have not yet proved satisfactory, or that purchasers are still watching the results, as few roads have placed a second order for such rails. We believe that until a more perfect workmanship can be attained in the straightening of 45 and 60-ft. rails they are not likely to be favorably received, however satisfactory they may be in other particulars. The subject should receive continued investigation, as the introduction of any means by which 50% of the rail joints can be successfully reduced will be a boon to railways generally.

Your committee can see no objections to 33-ft. rails, and would recommend their use. The advantages to be obtained are: Greater convenience in handling, transporting and maintaining and a reduction of 10% in joints. We have strong hope that further trial and improvement in manufacture and appliances may at no distant day render it practicable to recommend 45 and even 60-ft. rails.

Your committee regrets that from present information it cannot recommend miter-cut rails. The point of contact between wheel and rail is so slight that an opening at any particular angle will cause a blow, and as the mitered points are unsupported by the web of the rail, we believe that the depression or flattening at the joints will be about as rapid as with the square-cut rails. Evidence from two prominent roads where mitered rails cut at an angle of 55° have been in hard service for four and five years, show fairly satisfactory results. Other roads, after nine years' trial, are not placing any orders for mitered rails. We are satisfied, from information gathered, that in some instances, at least, the unsatisfactory condition of the rails has been caused by too great expansion space having been allowed.

In determining the difference in expansion of light and heavy rails, your committee labored under the disadvantage of having no means at hand of making entirely accurate measurements. Our experiments in determining the difference in expansion in different weights were made by constructing a timber platform (wood being used because little affected by extremes of heat and cold), and on this platform, when the temperature of the air registered 5° F., were laid one 30-ft. 56-lb. rail, one 30-ft. 75-lb. rail, and one 30-ft. 85-lb. rail, the length of each rail at that temperature being registered. A comparative statement of the contraction and expansion, as indicated by our experiment, is given herewith.

Contraction of rails caused by change of temperature from + 5° to — 20° F. (making a difference or change of 25°).—56-lb. rail contracted 3-16-in., or .0075 per degree; 75-lb. rail contracted 2-16-in., or .005 per deg.; 85-lb. rail contracted 2-20-in., or .004 per deg.

Expansion of rails caused by change of temperature from + 5° to + 70°.—56-lb. rail expanded 1-12-in., or .00128 per degree; 75-lb. rail expanded 1-16-in., or .00096 per deg.; 85-lb. rail expanded 1-17-in., or .0009 per deg.

From this your committee concluded that heavy rails are less affected than light rails by the extremes of heat and cold, and this is borne out by the experience of practical trackmen. The importance of the work may be better appreciated when we take into consideration the fact that the amount of expansion space, to a great extent, determines the life of the rail. In view of the importance of determining definitely the space necessary to be allowed in laying rails of different weights, your committee would recommend that a committee be appointed with authority to employ methods and appliances necessary to make an accurate record and report of the expansion and contraction of rails varying from 60 to 100 lbs. per yd., at temperatures of as wide range as practicable; also to ascertain definitely the difference in expansion of 30 and 60-ft. rails.

V. T. Douglas, G. W. Merrell, Committee.

Standard Car and Track Gages.

The M. C. B. wheel gage, which was at first intended to be a compromise, has been improved and perfected, and in its present shape may be considered almost the absolute standard of all standard-gage railways of North America. The term "compromise cars" can now be properly applied only to cars with wheels cast prior to Aug. 31, 1894, and which come within the limits provided by M. C. B. rules for such wheels. From the nature of the service, these wheels must by this time have been almost all worn out and retired from service, and it can only be a question of a short time when they will not enter into the question of interchange at all.

There are in the United States, Canada and Mexico, about 208,800 miles of main line so-called standard gage track, divided about as follows:

	Miles.
4 ft. 8½ ins., or standard gage	177,400
4 " 9 " gage	30,200
4 " 8¾ " "	1,200
Total	208,800

Of this mileage, 171,000, or 82% of the total, have adopted the M. C. B. rules of interchange,and the M. C. B. standard car gage. All the important 4 ft. 9-in. roads have adopted them. The small per cent. not represented consists entirely of small roads, closely connected with the larger 4 ft. 9-in. systems, and entirely dependent on them for interchange of cars. We may, therefore, assume that all 4 ft. 9-in. roads are bound by the M.C.B. rules. There are still some few important 4 ft. 8½-in. roads which have not adopted the M. C. B. rules, but they are so surrounded by roads which have, that in self defense they are obliged to use M. C. B. standard gage. Almost all important private car lines have adopted the M. C. B. rules. This leaves us, then, with practically only the M. C. B. standard gage, the very slight variations in setting allowed, and the flange wear allowed under the M. C. B. rules, to consider. The question then becomes: "Is the M. C. B. car gage of 4 ft. 8⅛ ins. the proper car gage for our track?"

As far as the standard, or 4 ft. 8½-in. gage roads are concerned,the question can be answered in the affirmative. It provides for a 4 ft. 8½-in. standard gage, not to exceed 4 ft. 8¼ ins., thus giving a flange play of ⅝-in. generally, and ¼-in. in the worst cases, which is ample. For back to back of flanges it provides a standard of 4 ft. 5⅜ ins., which shall not be less than 4 ft. 5¼ ins., thus giving, generally, ⅜-in. guard rail and frog wing play, and ¼-in. in the worst cases. This is perfectly safe.

When we come to the wear allowed, we find that the car gage may be reduced to 4 ft. 7¼ ins., or 1¼-in. flange play. While such an open gage is not good for the track it is perfectly safe, and as some compromise must always be made between track and cars, this seems a reasonable one, as otherwise the cost of removing car wheels might amount to more than the saving in track labor, which would result from maintaining the car gage closer to the track gage.

The M. C. B. Association, in trying to make a car gage that would be safe on both 4 ft. 8½-in. and 4 ft. 9-in. gages, have very much improved the gage for the 4 ft. 8½-in. roads. I think it is now generally conceded that by making the car gage as close to the track gage as can be done with safety, the wear, both of the rails and wheels is reduced, and the maintenance of line and surface of track is made cheaper and easier.

As to the standard car gage on 4 ft. 9-in. track gage. From a roadway point of view this is bad. The standard car gage starts with a side play of ⅞-in. on such track, and is allowed to wear to 1¾-in. side play. This excessive side play is very destructive to line and surface, especially on roads using light ballast. The side play of ⅞-in., which new wheels have, cannot be other than very injurious, and when wheels are worn to the limit, giving 1¾-in. side play, it is simply ruinous. In case there is a low joint, every car in the train will run to it, with all the extra play to help give it a hammer blow, and that joint has to go out of line. On the return the cars go to the other side, with the side play in boxes brought into play to help hammer the line, and thus the train keeps on its way, first striking one side and then the other, and leaving bad track behind it. It requires much more time and labor spent on line and surface to maintain a fair track on 4 ft. 9-in. roads than on 4 ft. 8½-in. roads.

The life of frogs is another consideration. The extra opening at the throat, which the wider gage calls for, very largely increases the hammer blow on points and wings of frogs and materially lessens their life. Where a 4 ft. 9-in. road uses M. C. B. gage on the passenger equipment, as a great many do, the comfort of travel enters in. There is no doubt that a standard gage car will ride as well on a 4 ft. 9-in. track as it will on standard gage, provided the track is perfect in line and surface. But few of us are able to keep perfect track at all times, and when a standard gage car strikes a bad place on 4 ft. 9-in. track, it is exaggerated and carried forward until a few low joints are made to ride like a quarter of a mile of bad track.

To insure the same degree of comfort in travel, the line and surface of 4 ft. 9-in. track has to be maintained in a much higher state of perfection than the standard gage. This makes two causes for increased labor on 4 ft. 9-in. track. To secure the same result as standard gage track, it has to be kept in better condition than standard track, and the looseness of the car gage makes it harder to keep it in the same condition as standard gage tracks under the same traffic.

As the car gage is fixed, the only way left for the 4 ft. 9-in. roads to get rid of the excessive play between rails

and wheels is to draw their gage in to the 4 ft. 8½-in., or standard gage. This is not such a big undertaking as it may appear at first thought.

All rolling stock, with the possible exception of some few passenger cars, is now made for the 4 ft.8½-in. gage track. All engines will run on 4 ft. 8½-in. tangents, and most engines for a 4 ft. 9-in. gage will take light curves on 4 ft. 8½-in. gage. This change of track gage can be made in two or three years, taking first the tangents that require the heaviest timbering and drawing in the gage as the cross-ties are put in. The curves can be left to the last. At the same time the shops can begin to draw in the engine wheel gage as tires have to be renewed, and by the time the roadway is ready to change the gage on curves all the engines can have been brought to the proper gage for 4 ft. 8½-in. track, without any extra expense. The expense to the road forces, of making the change, would hardly be felt, and the resulting saving in maintenance and the added comfort in travel would more than pay for the small cost of the change in a very short time.

C. C. Dunn.

The Relation of Track to Traffic.

We seek that condition of track which, while contributing to the reduction of the general repair expenditure and cost of movement, shall at the same time be capable of maintenance at the minimum of expenditure.

The demand of the public has been obeyed in increased weight and speed of trains, and the weight of the car-load has been enormously increased, while the corresponding advance in track construction has never been fully made. On the majority of our roads it is doubtful if the comparative relations of track and traffic are an improvement upon those of 30 years ago. The resultant additional cost in all departments is not known, but we do know fairly well that we expend annually over $40,000,000 for labor in lining and surfacing track. For this enormous outlay track sufficiency should equal that of equipment, but all know how far short it comes.

When the finance department of a railway, whose roadbed and track has notoriously depreciated, successfully resist the urgent appeal of operating officials for a larger apportionment for maintenance of way, in the general appropriation for betterments, on the ground that most is needed for cars and engines—"something that would earn dividends," it makes a creditable display of zeal in the supposed interest of the stockholders, but entire want of experience in, or acquaintance with railway economics, blinds that department to the fact that eventually maintenance of way contributes as much to the earning power as any other department, and that upon a competitive road poor track and poor equipment are, in this respect, upon a practical equality when the yearly statement is made up.

It is complained of us that we are professionally conservative, relying upon precedent, upon the accepted theories taught us, with indisposition to consider suggestions at variance with accepted theories, and a persistent waiting for a demonstration by some one else. We must at least concede that progress has been slower with us than in other branches of the service, and there is a possibility worth considering that in the matter under discussion engineering must divide responsibility with finance.

Who originated the teaching that stones 2½ ins. diameter were the best things to tamp under ties? Trackmen know they are not, but the theory and the practice remain with us in authority. We are still impressed with the theory of the "wave of depression" and its necessity,and with the necessity for excessive provision for the expansion and contraction of rails. Yet there are many heretical as to the former, and some (dating back to the elder Trautwine) as to the latter.

For years we have annually appointed a committee to report upon a method to check the tendency of track to creep and we only get reports of devices that have been tried, and the creeping continues. The idea has been advanced that the rail section can be so rolled that it will not creep, and at an additional cost no greater than the inefficient devices that have been tried to prevent it. So with the joint device with which engineers, trackmen and inventors have struggled for half a century. It is asserted by practical students and experimenters that ultimately we must rely upon weight and strength of metal, instead of mechanical arrangements of parts. Meanwhile we must be content with the low-priced, easily applied angle-bar, and wait for some one to demonstrate the soundness of these theories.

Are we sure of our ground in our conception and definition of the rail section? Is it governable by the law of the beam? We claim for it that "the change of its form from the curious and clumsy iron pear-head of 30 years ago to the present refined section of steel, is a scientific development," but from the amount of money that we spend for rail braces and tie-plates, to prevent their tipping over, and the costly derailments that do occur from so-called "spreading track," which means tipping over (as track kept fit for use will not spread to a derailing point), there is ground for suspicion that there is a flaw in our theory. The mechanical engineer may possibly be nearer right in saying that "In metal beams the effect of thickening the sections add more than proportionately to the ultimate strength and very considerable to the stiffness."

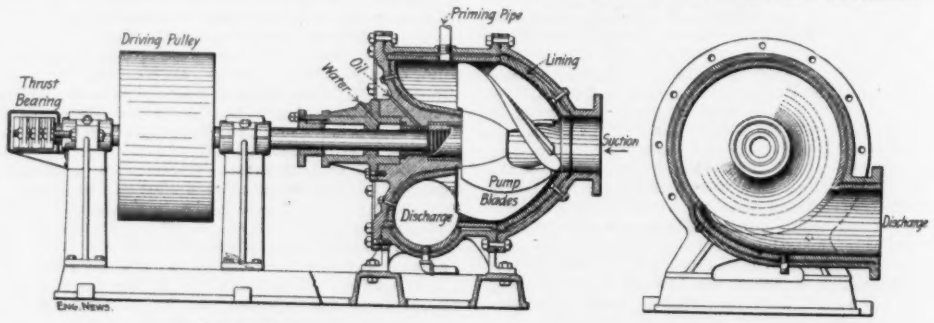
General managers and superintendents are dissatisfied with the durability of the newer and heavier rails as compared with its predecessor, and here we claim freedom from responsibility. When the financial department ask for lowest bids on a given section, of a given analysis, the mill man builds larger machinery, for the largest machinery will squeeze the metal into the required shape at the least cost, and hence the result. No peculiarity or nicety of analysis can ever compensate for deficient working, and proper working the mill man is not paid for.

In concluding a paper advocating as economy heavier and better material in roadway and its superstructure, and in questioning some theories taught us as conclusive, the writer repeats the query of a distinguished late Vice-President of a great system to his associates of the American Society of Civil Engineers, to this effect: "Given a wheel whose periphery is a circle, and a rail correct in alinement, with an anvil beneath it, why not expect the maximum of service with the minimum expenditure of power?" He has heard of no answer to it other than a tradition of the days of George Stephenson, nor shall he attempt one; for startling as was the proposition it is in line with the writer's own conviction. F. R. Coates.

A CENTRIFUGAL PUMP FOR DREDGING AND MINING WORK.

The centrifugal pump which we illustrate this week is intended specially for handling water charged with sand and gravel, and differs materially from other forms of centrifugal pumps which have been applied for handling the same character of material in dredging and similar work. On the end of a steel shaft is fitted a boss carrying curved blades, somewhat on the principle of a screw propeller, the head of the boss being directly opposite the suction pipe. The pump runner revolves in a cylindrical chamber having a hemispherical head, the suction being in the center of the head and the discharge at the bottom of the cylindrical chamber in a direction tangential to the runner. The pump chamber has a lining of hard iron, which can be renewed when worn. The shaft is driven by a belt pulley, and is supported by two pillow block bearings and a long sleeve bearing in the pump chamber. Beyond the packing gland is a chamber in which water pressure is maintained, the water flowing out through the sleeve, and thus preventing sand from working into the sleeve bearing. At the outer end of the shaft is the thrust bearing to resist the longitudinal thrust due to the form of the pump runner. The whole machine is bolted to a cast-iron bed plate.

The blades of the runner are developed from a perfect screw of extended pitch, their points being spoon shaped in order to aid in forcing the material through and to prevent any reaction from the water. The flat face of



Sectional Side Elevation. Section of Pump Shell.

CENTRIFUGAL PUMP FOR DREDGING AND MINING WORK.
D. Clint Prescott Co., Builders.

the rear of the blade drives the material out through the discharge pipes. It is desirable to deflect the stream of water and solid matter away from the inside of the casing and to confine its movement mainly along the central portions of the blades as it passes to the rear. To effect this the outer edges of the blades are rounded or curved at the front, being deeper or more full towards the points, this curve disappearing entirely at the rear, where the blades are made flat. It will be noted that the rear ends of the blades are flanged at right angles to the shaft for a short distance, the flange serving to compress all material into the receiving chamber and thence out into the discharge opening, into which all the heavy material falls by gravity.

Some of these pumps are in use by the Franklin Mining Co. and the Centennial Mining Co., of Hancock, Mich., being used to elevate "slimes" (sand and gravel mixed with water) which come from the stamp mills after the copper has been removed from the ore.

The machine is styled the Libbey-Prescott pump, and is manufactured by the D. Clint Prescott Co., 1404 Monadnock Block, Chicago, Ill., the company's works being at Menominee, Mich.

THE PROPOSED NEW BUILDING CODE FOR NEW YORK CITY.

The growing discontent of engineers and architects with the present building laws of New York city resulted last January, as some of our readers will remember, in the appointment of a special commission to draft an entirely new code of laws to govern building operations in that city. This commission consisted of the following members: Thomas J. Brady, Building Commissioner, New York and Bronx; John Guilfoyle, Building Commissioner, Brooklyn; Daniel Campbell, Building Commissioner, Queens and Richmond; Wm. J. Fryer; Robert McCafferty; Geo. A. Just, M. Am. Soc. C. E.; Cornelius O'Reilly; Bernard Gallagher; Daniel Callahan, and Rollin M. Morgan, and since its organization in January last it has been pretty steadily at work on the problem which it had to solve. Numerous hearings were held, after which a tentative code was drawn up. This tentative code was then submitted to the criticism of the various engineering, architectural and builders' societies, and to various other interested clubs and societies, and to individual engineers, architects, builders, etc. As a rule these different organizations and individuals were quite prompt to grasp the opportunity which was offered to them, but we regret to say that as a general thing engineers were very negligent in giving it attention, and that as many responded as did was largely owing to the personal efforts of the engineer member of the commission.

Altogether the new code consists of 36 sections, as follows: (1) Short Title of the Ordinance; (2) Preliminary Requirements; (3) Definitions; (4) Quality of Materials; (5) Excavations and Foundations; (6) Walls, Piers and Partitions; (7) Apartment, Tenement and Dwelling-Houses of Certain Heights; (8) Vaults, Areas and Cellars; (9) Wood Beams, Girders and Columns; (10) Chimneys, Flues, Fireplaces and Heating Pipes; (11) General Construction; (12) Stairs and Entrances; (13) Skylights and Floor Lights; (14) Inclosures and Shed Coverings for Protection of Pedestrians; (15) Miscellaneous Buildings; (16) Heating Apparatus, Drying-Rooms, Gas and Water Pipes; (17) Roofs, Leaders, Cornices, Bulkheads, Scuttles and Tanks; (18) Elevators, Hoistways and Dumb-Waiters; (19) Fire Appliances, Fire Escapes, and Fireproof Shutters and Doors; (20) Fireproof Buildings; (21) Public Buildings, Theaters, and Places of Assemblage; (22) Iron and Steel Construction; (23) Floor Loads—Temporary Supports; (24) Calculations, Strength of Materials; (25) Plumbing and Drainage; (26) Buildings Raised, Lowered, Altered or Moved; (27) Fire Limits; (28) Frame Buildings; (29) Appeals and Modifications of Law; (30) Violations, Penalties, Courts Having Jurisdiction; (31) Unsafe Buildings, Surveys, Court Proceedings; (32) Recovery of Bodies Under Fallen Buildings; (33)

Fund for Use and Benefit of the Department of Buildings; (34) Seal; (35) Existing Suits and Liabilities; (36) Date When Ordinance Takes Effect. The great length of the code precludes the possibility of giving more than a brief abstract of the sections which relate to the points which have been most in dispute in the present ordinance, but the preceding summary shows quite well the scope of the ordinance. Taken as a whole, the new code indicates notably that an attempt has been made to base its various provisions on modern knowledge and practice in engineering construction. Valued at the very least, it is a decided improvement on the present law, although that is not saying much, as any of our readers who are familiar with the matter will know without telling.

The following are brief extracts from those sections of the code which are of most interest to engineers:

Bearing Capacity of Soil.—Where no test of the sustaining power of the soil is made different soils, excluding mud, at the bottom of the footings shall be deemed to sustain safely the following loads to the superficial foot, namely: Soft clay, 1 ton per sq. ft.; ordinary clay and sand together, in layers, wet and springy, 2 tons per sq. ft.; loam, clay or fine sand, firm and dry, 3 tons per sq. ft.; very firm, coarse sand, stiff gravel or hard clay, 4 tons per sq. ft., or as otherwise determined by the Commissioner of Buildings having jurisdiction.

Pressure Under Footings of Foundations.—The loads exerting pressure under the footings of foundations in buildings more than 3 stories in height are to be computed as follows: For warehouses and factories they are to be the full dead load and the full live load; in stores and buildings for light manufacturing purposes they are to be the full dead load and 75% of the live load; in churches, school houses and places of public amusement or assembly, they are to be the full dead load and 75% of the live load; in office buildings, hotels, dwellings, apartment-houses, tenement-houses, lodging-houses and stables, they are to be the full dead load and 60% of the live load established by section 130 of this code.

Section 130 of the code which is here referred to covers the question of floor loads, and is in abstract as follows:

Every floor shall be of sufficient strength to bear safely the weight to be imposed thereon in addition to the weight of the materials of which the floor is composed; if to be used as a dwelling-house, apartment-house, tenement-house, hotel or lodging-house, each floor shall be of sufficient strength in all its parts to bear safely upon every superficial foot of its surface not less than 60 lbs.; if to be used for office purposes, not less than 75 lbs. upon every superficial foot above the first floor, and for the latter floor, 150 lbs.; if to be used as a school or place of instruction, not less than 75 lbs. upon every superficial foot; if to be used for stable and carriage-house purposes, not less than 40 lbs. upon every superficial foot; if to be used as a place of public assembly, not less than 90 lbs. upon every superficial foot; if to be used for ordinary stores, light manufacturing and light storage, not less than 120 lbs. upon every superficial foot; if to be used as a store where heavy materials are kept or stored, warehouse, factory or for any other manufacturing or commercial purpose, not less than 150 lbs. upon every superficial foot. The strength of factory floors intended to carry running machinery shall be increased above the minimum given in this section in proportion to the degree of vibratory impulse liable to be transmitted to the floor, as may be required by the Commissioner of Buildings having jurisdiction.

Wood Beams.—The safe carrying capacity of wood beams for uniformly distributed loads shall be determined by multiplying the area in square inches by its depth in inches, and dividing this product by the span of the beam in feet. This result is to be multiplied by 70 for hemlock, 90 for spruce and white pine, 124 for oak, and by 140 for yellow pine. The safe carrying capacity of short span timber beams shall be determined by their resistance to shear in accordance with the unit stresses fixed by section 139 of this code.

The unit stresses in Section 139, which are referred to here, are as follows:

Material.	Direct compression, lbs. per sq. in. With grain.	Across grain
Oak	900	800
Yellow pine	1,000	600
White pine	800	400
Spruce	800	400
Locust	1,200	1,000
Hemlock	500	500
Chestnut	500	1,000

Concerning the much-disputed matter of cast-iron columns, the new code contains the following provisions:

Cast-iron Columns.—Cast-iron columns shall not have less diameter than 5 ins., or less thickness than ¾-in.; nor shall they have an unsupported length of more than 20 times their least lateral dimensions or diameter, except as modified by section 138 of this code, and except the same may form part of an elevator enclosure or staircase, and also except in such cases as the Commissioner of Buildings having jurisdiction, may specially allow a greater unsupported length. All cast-iron columns shall be of good workmanship and material. The top and bottom flanges, seats and lugs shall be of ample strength, reinforced by fillets and brackets; they shall be not less than 1-in. in thickness when finished. All columns must be faced at the ends to a true surface perpendicular to the axis of the column. Column joints shall be secured by not less than four bolts each, not less than ¾-in. in diameter. The holes for these bolts shall be drilled to a template. The core of a column below a joint shall not be larger than the core of the column above and the metal shall be tapered down for a distance of not less than 6 ins., or a joint plate may be inserted of sufficient strength to distribute the load. The thickness of metal shall be not less than 1-12th the diameter or the greatest lateral dimension of cross-section, but never less than ¾-in. Wherever the core of a cast-iron column has shifted more than one-fourth the thickness of the shell, the strength shall be computed assuming the thickness of metal all around equal to the thinnest part, and the column shall be condemned if this computation shows the strength to be less than required by this code. Wherever blowholes or imperfections are found in a cast-iron column which reduces the area of the cross-section at that point more than 10%, such columns shall be condemned. Cast-iron posts or columns not cast with one open side or back, before being set up in place, shall have a ⅜-in. hole drilled in the shaft of each post or column, by the manufacturer or contractor furnishing the same, to exhibit the thickness of the castings; and any other similar sized hole or holes which the Commissioners of Buildings may require, shall be drilled in the said post or columns by the said manufacturer or contractor at his own expense. Iron or steel shoes or plates shall be used under the bottom tier of columns properly to distribute the load on the foundation. Shoes shall be planed on top.

Factors of Safety.—Where the unit stress for any material is not prescribed in this code, the relation of allowable unit stress to ultimate strength shall be as 1 to 4 for metals subjected to tension or transverse stress; as 1 to 6 for timber, and as 1 to 10 for natural or artificial stones and brick or stone masonry. But wherever working stresses are prescribed in this code, varying the factors of safety hereinabove given, the said working stresses shall be used.

Strength of Columns.—In columns or compression members with flat ends of cast-iron, steel, wrought iron or wood, the stress per square inch shall not exceed that given in the following tables:

When length is divided by least radius of gyration equals:	Working stresses, lbs. per sq. in. of section. Cast-iron.	Steel.	Wrt.-iron.
120	.....	8,240	4,400
110	.....	8,820	5,200
100	.....	9,400	6,000
90	.....	9,980	6,800
80	.....	10,560	7,600
70	9,200	11,140	8,400
60	9,800	11,720	9,200
50	9,800	12,300	10,000
40	10,400	12,880	10,800
30	10,400	13,460	11,600
20	10,400	14,040	12,400
10	11,000	14,620	13,200

And in like proportion for intermediate ratios.

When length, divided by the least diameter equals—	Long leaf yellow pine.	White pine, Norway pine spruce.	Oak.
30	400	350	380
25	550	425	475
20	640	500	560
15	730	575	645
12	784	620	686
10	820	650	730

And in like proportion for intermediate ratios. Five-eighths of the values given for white pine shall also apply to chestnut and hemlock posts. For locust posts use one and one-half the value given for white pine. Columns and compression members shall not be used having an unsupported length of greater ratios than given in the tables. Any column eccentrically loaded shall have the stresses caused by such eccentricity computed, and the combined stresses resulting from such eccentricity at any part of the column, added to all other stresses at that part shall in no case exceed the working stresses stated in this code. The eccentric load of a column shall be considered to be distributed equally over the entire area of that column at the next point below at which the column is securely braced laterally in the direction of the eccentricity.

The following is an abstract of the sections relating to fire protection and fireproof construction, and are of particular interest in view of the severe criticism which the same sections in the present law have deservedly received from engineers:

Auxiliary Fire Apparatus for Buildings.—In every building now erected, unless always provided with a 3-in. or large vertical pipe, which exceeds 100 ft. in height and in every building hereafter to be erected exceeding 85 ft. in height, and when any such building does not exceed 100 ft. in height, it shall be provided with a 4-in. stand-pipe, running from cellar to roof, with one two-way, 3-in. Siamese connection to be placed on street above the curb level, and with one 2½-in. outlet, with hose attached thereto on each floor, placed as near the stairs as practicable; and all buildings now erected unless already provided with a 3-in. or large vertical pipe or hereafter to be erected exceeding 150 ft. in height, shall be proved with an auxiliary fire apparatus and all appliances, consisting of water tank on roof, or in cellar, stand-pipe, nozzles, wrenches, fire extinguishers, hooks, axes and other such appliances as may be required by the Fire Department; all to be of the best material and of the sizes, patterns and regulation kinds used and required by the Fire Department. In every such building a steam pump and at least one passenger elevator shall be kept in readiness for immediate use by the Fire Department, during all hours of the night and day, including holidays and Sundays. Stand-pipes shall not be less than 6 ins. in diameter for all buildings exceeding 150 ft. in height. All stand-pipes shall extend to the street and there be provided at or near the sidewalk level with the Siamese connections. Said stand-pipes shall also extend to the roof. Valve outlets shall be provided on each and every story, including the basement and cellar, and on the roof. All valves, hose, tools, and other appliances provided for in this section shall be kept in perfect working order, and once a month the person in charge of said building shall make a thorough inspection of the same to see that all valves, hose and other appliances are in perfect working order, and ready for immediate use by the Fire Department. If any of the said buildings extend from street to street, or form an L-shape, they shall be provided with stand-pipes for each street frontage. In such buildings as are used or occupied for business or manufacturing purposes, there shall be provided, in connection with said stand-pipe or pipes, 2½-in. perforated iron pipes placed on and along the ceiling line of each floor below the first floor and extending to the full depth of the building. Such perforated pipe shall be provided with a valve placed at or near the stand-pipe, so that water can be let into same when deemed necessary by the firemen, or in lieu of such perforated pipes automatic sprinklers may be put in. When the building is 25 ft. or less in width, two lines of perforated pipe shall be provided, and one line additionally for each 12½ ft. or part thereof that the building is wider than 25 ft.

Fireproof Shutters and Doors.—Every building which is more than two stories in height above the curb level, except dwelling-houses, hotels, school-houses and churches, shall have doors, blinds or shutters made of iron, hung to iron hanging frames or to iron eyes built into the wall, on every exterior window and opening above the first story thereof, excepting on the front openings of building fronting on streets which are more than 30 ft. in width, or where no other buildings are within 30 ft. of such openings. The said doors, blinds or shutters may be constructed of pine or other soft wood of two thicknesses of matched boards at right angles with each other, and securely covered with tin, on both sides and edges, with folded lapped joints, the nails for fastening the same being driven inside the lap; the hinges and bolts, or latches shall be secured or fastened to the door or shutter after the same has been covered with the tin, and such doors or shutters shall be hung upon an iron frame, independent of the woodwork of the windows and doors, or two iron hinges securely fastened in the masonry; or such frames, if of wood, shall be covered with tin in the same manner as the doors and shutters. All shutters opening on fire escapes, and at least one row, vertically, in every three rows on the front window openings, above the first story of any building, shall be so arranged that they can be readily opened from the outside by firemen. All rolling iron or steel shutters hereafter placed in the first story of any building, shall be counterbalanced so that said rolling shutters may be readily opened by the firemen. No building hereafter erected, other than a dwelling-house or fireproof building, shall have inside iron or steel shutters to windows above the first story. All windows and openings above the first story of any building may be provided with other suitable protection or may be exempted from having shutters by the Board of Buildings or the Board of Examiners as the case may be. All buildings specified in this section, hereafter erected or altered, having openings in interior walls, shall be provided with suitable fireproof doors where deemed necessary by the Commissioner of Buildings having jurisdiction. All occupants of buildings shall close all exterior and interior fireproof shutters, doors and blinds at the close of the business of each day.

Fireproof Buildings.—Every building hereafter erected or altered, to be used as a hotel, lodging-house, school, theatre, jail, police station, hospital, asylum, institution for the care or treatment of persons, the height of which exceeds 35 ft., excepting all buildings for which specifications and plans have been heretofore submitted to and approved by the Department of Buildings, and every other building the height of which exceeds 75 ft., except as herein otherwise provided, shall be built fireproof, that is to say, they shall be constructed with walls of brick, stone, Portland cement, concrete, iron or steel, in which wood beams or lintels shall not be placed, and in which the floors and roofs shall be of materials provided for in this code. The stairs and staircase landings shall be built entirely of brick, stone, Portland cement concrete, iron or steel. No woodwork or other inflammable material shall be used in any of the partitions, furrings or ceilings in any such fireproof buildings, excepting, however, that when the height of the building does not exceed 12 stories nor more than 150 ft., the doors and windows and their frames, the trims, the casings, the interior finish when filled solid at the back with fireproof material, and the floor boards and sleepers directly thereunder, may be of wood, but the space between the sleepers shall be solidly filled with fireproof materials, and extend up to the underside of the floor boards.

When the height of a fireproof building exceeds 12 stories, or more than 150 ft., the floor surfaces shall be of stone, cement, rock asphalt, tiling or similar incombustible material, or the sleepers and floors may be of wood treated by some process, approved by the Board of Buildings to render the same fireproof. All outside window frames and sash shall be of metal or of wood covered with metal. The inside window frames and sash, doors, trim

and other interior finish may be of wood covered with metal, or of wood treated by some process approved by the Board of Buildings to render the same fireproof.

All hall partitions or permanent partitions between rooms in fireproof buildings shall be built of fireproof material and shall not be started on wood sills, nor on wooden floor boards, but be built upon the fireproof construction of the floor and extend to the fireproof beams filling above. The tops of all door and window openings in such partitions shall be at least 12 ins. below the ceiling line.

Fireproof Floors.—Fireproof floors shall be constructed with wrought-iron or steel floor beams so arranged as to spacing and length of beams that the load to be supported by them, together with the weights of the materials used in the construction of the said floors shall not cause a greater deflection of the said beams than 1-30-in. per ft. of span under the total load; and they shall be tied together at intervals of not more than eight times the depth of the beam. Between the wrought iron or steel floor beams shall be placed brick arches springing from the lower flange of the steel beams. Said brick arches shall be designed with a rise to carry safely the imposed load, but never less than 1¼ ins. for each ft. of span between the beams, and they shall have a thickness of not less than 4 ins. for spans of 5 ft. or less, and 8 ins. for spans over 5 ft., or such thickness as may be required by the Board of Buildings. Said brick arches shall be composed of good, hard brick or hollow brick of ordinary dimensions laid to a line on the centers, properly and solidly bonded, each longitudinal line of brick breaking joints with the adjoining lines in the same ring and with the ring under it when more than a 4-in. arch is used. The brick shall be well wet and the joints filled in solid with cement mortar. The arches shall be well grouted and properly keyed. Or the space between the beams may be filled in with hollow tile arches or hard-burnt clay or porous terra cotta of uniform density and hardness of burn. The skew-backs shall be of such form and section as properly to receive the thrust of said arch; and the said arches shall be of a depth and sectional area to carry the load to be imposed thereon, without straining the material beyond its safe working load, but said depth shall not be less than 1⅝ ins. for each ft. of span, not including any portion of the depth of the tile projecting below the underside of the beams, a variable distance being allowed of not over 6 ins. in the span between the beams, if the soffits of the tile are straight; but if said arches are segmental, having a rise of not less than 1¼ ins. for each foot of span, the depth of the tile shall be not less than 6 ins. The joints shall be solidly filled with cement mortar as required for common brick arches, and the arch, so constructed that the key block shall always fall in the central portion. The shells and web of all end construction blocks shall abut, one against another. Or the space between the beams may be filled with arches of Portland cement concrete, segmental in form, and which shall have a rise of not less than 1¼ ins. for each ft. of span between the beams. The concrete shall be not less than 4 ins. in thickness at the crown of the arch and shall be mixed in the proportions required by section 18 of this cade. These arches shall in all cases be reinforced and protected on the underside with corrugated or sheet steel, steel ribs, or metal in other forms weighing not less than 1 lb. per sq. ft., and having no openings larger than 3 ins. square. Or between said beams may be placed solid or hollow burnt-clay, stone, brick or concrete slabs in flat or curved shapes, concrete or other fireproof composition, and any of said materials may be used in combination with wire cloth, expanded metal, wire strands, or wrought-iron or steel bars; but in any such construction and as a precedent condition to the same being used, tests shall be made as herein provided by the manufacturer thereof under the direction and to the satisfaction of the Board of Buildings, and evidence of the same shall be kept on file in the Department of Buildings, showing the nature of the test and the result of the test. Such tests shall be made by constructing within inclosure walls a platform consisting of four rolled steel beams, 10 ins. deep, weighing each 25 lbs. per lin. ft., and placed 4 ft. between centers, and connected by transverse tie-rods, and with a clear span of 14 ft. for the two interior beams and with the two outer beams supported on the side walls throughout their length, and with both a filling between the said beams, and a fireproof protection of the exposed parts of the beams of the system to be tested, constructed as in actual practice, with the quality of material ordinarily used in that system and the ceiling plastered below, as in a finished job; such filling between the two interior beams being loaded with a distributed load of 150 lbs. per sq. ft. of its area and all carried by such filling; and subjecting the platform so constructed to the continuous heat of a wood fire below, averaging not less than 1,700° F., for not less than four hours, during which time the platform shall have remained in such condition that no flame will have passed through the platform or any part of the same, and that no part of the load shall have fallen through, and that the beams shall have been protected from the heat to the extent that after applying to the underside of the platform at the end of the heat test a stream of water directed against the bottom of the platform and discharged through a 1⅛-in. nozzle under 60 lbs. pressure for five minutes, and after flooding the top of the platform with water under low pressure, and then again applying the stream of water through the nozzle under the 60 lbs. pressure to the bottom of the platform for five minutes, and after a total load of 600 lbs. per sq. ft. uniformly distributed over the middle bay shall have been applied and removed, after the platform shall have cooled, the maximum deflection of the interior beams shall not exceed 2½ ins. The Board of Buildings may from time to time prescribe additional or different tests than the foregoing for systems of filling between iron or steel floor beams, and the protection of the exposed parts of the beams. Any system failing to meet the requirements of the test of heat, water and weight as herein prescribed shall be prohibited from use in any building hereafter erected. Duly authenticated records of the tests heretofore made of any system of fireproof floor filling and protection of the exposed parts of the beams may be presented to the Board of Buildings, and if the same be satisfactory to said Board, it shall be accepted as conclusive. No filling of any kind which may be injured by frost shall be placed between said floor beams during freezing weather, and if the same is so placed during any winter month, it shall be temporarily covered with suitable material for protection from being frozen. On top of any arch, lintel or other device which does not extend to and form a horizontal line with the top of the said floor beams, cinder concrete or other suitable fireproof material shall be placed solidly to fill up the space to a level with the top of the said floor beams, and shall be carried to the underside of the wood floor boards in case such be used. Temporary centering when used in placing fireproof systems between floor beams, shall not be removed within 24 hours or until such time as the mortar or material has set. All fireproof floor systems shall be of sufficient strength safely to carry the load to be imposed thereon without straining the material in any case beyond its safe working load. The bottom flanges of all wrought-iron or rolled steel floor and flat roof beams, and all exposed portions of such beams below the abutments of the floor arches shall be entirely incased with hard-burnt clay, porous terra cotta, or other fireproof material allowed to be used for the filling between the beams under the provisions of this section, such incasing material to be properly secured to the beams.

The exposed sides and bottom plates or flanges of wrought-iron or rolled steel girders supporting iron or steel floor beams, or supporting floor arches or floors, shall be entirely incased in the same manner. Openings through fireproof floors for pipes, conduits and similar purposes shall be shown on the plans. After the floors are constructed no opening greater than 8 ins. square shall be cut through said floors unless properly boxed or framed around with iron. And such openings shall be filled in with fireproof material after the pipes or conduits are in place.

Incasing Interior Columns.—All cast-iron, wrought-iron or rolled steel columns, including the lugs and brackets on same, used in the interior of any fireproof building, or used to support any fireproof floor, shall be protected with not less than 2 ins. of fireproof material, securely applied. The extreme outer edge of lugs, brackets, and similar supporting metal may project to within ⅝-in. of the surface of the fireproofing.

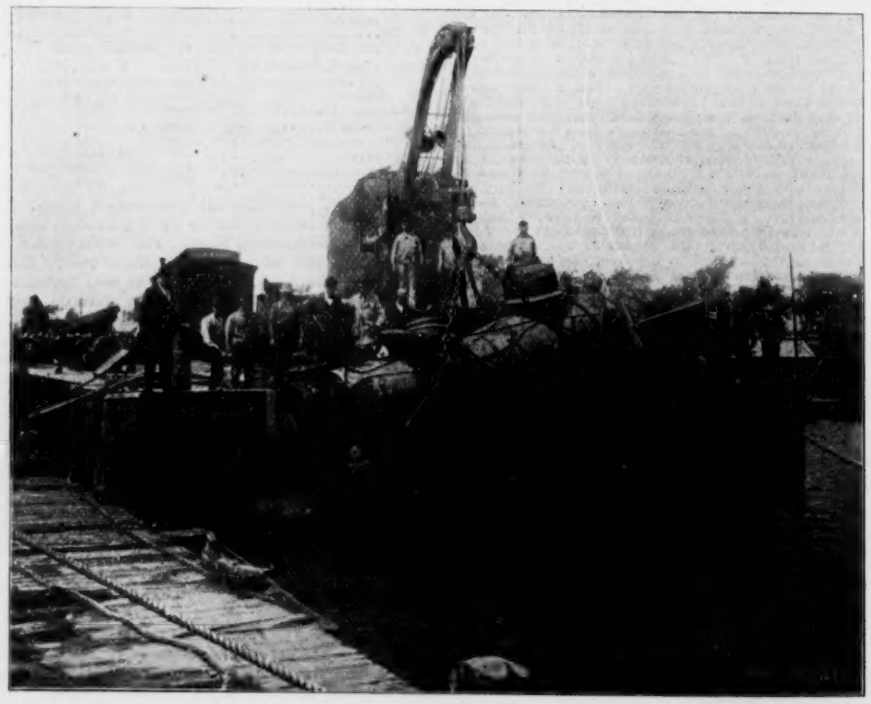
For the benefit of those of our readers who may desire to examine the full text of the new ordinance it may be stated that it was printed in full, in the "City Record," of New York city, for Sept. 7, 1899. The ordinance has been passed by the Board of Aldermen, and is now before the Council, where it has to be submitted to the Committee on Buildings. After being passed by the Council and approved by the Mayor the new code will become a law.

TWO ACCIDENTS DUE TO LACK OF BRAKING POWER.

On Aug. 31 a locomotive on the tracks of the Niagara Junction Ry., a terminal railway line on the lands of the Niagara Falls Power Co., was hauling a train of six empty and eight loaded cars, and had reached considerable speed to ascend an incline ahead. An open switch, which was not discovered by the engineer until he was close upon it turned the train onto a side track which led out on a dock a distance of several hundred feet. The locomotive had a steam brake applied to two of the drivers, and the engineer at once put it on and whistled for the brakemen to set the hand brakes, the train not being equipped with air. Despite all efforts, however, the train proceeded to the end of the switch, and the locomotive and the six empty cars went off the end of the dock into some 18 ft. of water. Our illustration represents the locomotive being hoisted out on Sept. 5 by a wrecking crane of the New York Central R. R., which also hoisted out the car bodies. The trucks and other portions of the wreck were previously hoisted out by the Buffalo Dredging Co.

The photograph is a good illustration of the reason for the demands of railway officers that wrecking outfits shall be capable of hoisting a whole locomotive.

The second accident was a runaway of two flat cars on the New York & Greenwood Lake R. R., which finally collided with a passenger train and caused a wreck in which one man was killed and several were injured. The cars were loaded with flagstones, and started down a steep grade at Montclair. A brakeman who was on the cars tried to stop them, but found one brake inoperative and the other he set so hard that the brake-chain broke. The road is a double-track line, and there were plenty of opportunities to turn the runaways onto the other track, or onto a siding, as the cars ran for a distance of five miles, passing eight different stations, and near the foot of the grade collided with the passenger train, as before stated. The station masters who saw the runaway probably assumed that the brakeman would be able to stop the cars. It is of interest to note that the road is operated under a block system controlled by the station masters.



HOISTING OUT A WRECKED LOCOMOTIVE, NIAGARA JUNCTION R. R., NIAGARA FALLS, N. Y., SEPT. 5, 1899.